The Dock and Harbour Authority

No. 207. Vol. XVIII. Edited by BRYSSON CUNNINGHAM, D.Sc., B.E., F.R.S.E., M.Inst.C.E. JANUARY, 1938

Editorial Comments

New Year Greetings.

We take the opportunity of extending to our readers sincere wishes for a happy and prosperous New Year.

An Ill-fated Port.

With its tragic experience still fresh in mind, we should be lacking in the feelings of ordinary humanity to write about the City of Shanghai without a keen sense of pity and commiseration for its unfortunate inhabitants, who have been the victims of that latest and crowning phase of civilised warfare: indiscriminate slaughter. Not that Shanghai has been exempt from warlike visitations in the past. There was the capture of the city, or rather of the native quarter, in 1853, by a band of insurgents who held it for eighteen months, and again in 1860 and 1861, when truculent rebels advanced to the walls, to be driven back, however, by British troops and volunteers. It was in this connection that the renowned General Gordon acquired his distinctive title of "Chinese Gordon," through taking over the command of the indisciplined Chinese army, and bringing it up to a standard of efficiency which it had not previously known.

But China is a country of strange vicissitudes, and the events of the last few months are only in accordance with the experiences of the past. A great nation, with an ancient civilisation, but inchoate, disorganised and torn by internal dissensions, she has repeatedly been at the mercy of lawless invaders, and her borders have been encroached upon from time to time, not least by those who, attracted by the possibilities of trade, have brought with them the benefits of settled administration.

Shanghai has always exercised an attraction for the commercial adventurer. Located in a favourable situation close to the estuary of one of the largest navigable rivers in the world, on the easternmost central point of the Chinese seaboard, it is the natural outlet for the vast area of the basin of the Yangtze, which is a richly productive region, at the same time that it provides a market for large quantities of Chinese goods, imported for local use and partly for re-export. It may be said without exaggeration that on account of the physical conformation of the country and its geographical barriers, Shanghai has for its hinterland nearly half of China proper. It enjoys, with Hong Kong, the distinction of being a principal centre of Eastern trade for the countries of both hemispheres.

A descriptive account of the Port of Hong Kong appeared in the issue of this Journal for December, 1936, and the leading article and illustrated Supplement of this number form a fitting sequel thereto. Whether, in the course of the warfare now raging, Hong Kong will suffer in any degree, is a matter for conjecture, but the fate of the whole of China is in the balance and, with a bitter and implacable adversary, the circumstances afford slight ground for optimistic hopes about the future. This country may be thankful if it escapes embroilment in a conflict in which British interests are unfortunately involved to an extent which calls for the exercise of the highest diplomacy and restraint.

War-time Conditions at Ports.

With wars and rumours of wars so much afloat in the air, however desirable it may be to avoid an alarmist attitude, it will be felt that the article on "War-time Port Operation" by Mr. Ross-Johnson, which appears in this issue, is very timely. The unfortunate confusion which prevailed in the last war at many British ports, due to the movement of troops and military stores without regard to the interruption and dislocation of the normal operations of overseas trade was an experience which must not be repeated. Certain restrictions are, of course, inevitable and have to be endured. But commerce is the life-blood of a country, and in the case of the British Isles, overseas traffic and trade must be maintained at all costs, if the nation is not to perish for lack of supplies, both in food and manufacturing material. Mr. Ross-Johnson, from his own profound knowledge of the result of chaotic disorder on dock quays and in transit sheds, is able to point out some useful lessons which it behoves those in charge of military operations to consider very carefully, lest while they are engaged in protecting the country from invasion, they overlook the vital necessity of keeping it in existence.

Coastal Shipping and the Smaller Ports.

In an address to the British Motor and Sailing Ship Owners' Association on the occasion of the Annual Meeting in December, Mr. W. J. Everard, the President, made allegations of lack of a progressive policy on the part of certain minor port authorities of this country. His motive was to urge the provision of such facilities and improvements as were required to meet the needs of the coastal trade. This was necessary, he said, if full advantage was to be taken of the determination of coasting owners to maintain and develop coastwise shipping by providing up-to-date ships and efficient working arrangements.

"I am afraid," he added, "that in my experience in the last twelve months, there has been a regrettable tendency on the part of one or two authorities to under-estimate the essential need of making adjustments in dues and providing small inexpensive additional facilities, with the result that several thousands of tons of traffic have been lost to rail and road."

This is a rather serious indictment of the enterprise and initiative of the port authorities concerned, and, if substantiated, should call for their serious reflection. The coastal trade is showing signs of a welcome revival, which is to be encouraged to the utmost in the interests of the national economy. There may, of course, be another side to the matter, and it would be interesting, as well as fair, to hear what the accused authorities have to say in their defence. As Mr. Everard's speech has been widely circulated, it is surely incumbent on them to reply or to take action to remove the cause of complaint.

The Proposed Bridge over the Severn.

The proposal for a bridge over the Severn Estuary having been revived since the rejection by Parliament of the Bill of 1936, the Minister of Transport has been busy during the past month, receiving deputations on both sides of the question: one in support and the other in opposition. On behalf of the latter view, it was urged that great apprehension was felt by navigational interests, who were of the opinion that the construction of such a bridge would interfere with navigation, and obstruct what is now a natural traffic highway. The bridge, it was contended, is not a public need, much less a national necessity, and in any event the serious effect on the Port of Gloucester and the system of waterways and industries associated therewith would far outweigh any advantages which a bridge might confer. The Minister (Dr. Burgin) assured the hostile deputation that he would not be prepared to support a scheme unless he were satisfied, after full investigation, that its effect would not be that which the deputation feared.

Editorial Comments—continued

A Uniform System of Buoyage.

The reproduction in this issue of the address by Mr. Mackenzie at the Inter-State Conference of Australian Harbour Authorities comes appropriately with the issue of the blue book by H.M. Stationery Office on the International Agreement for a Uniform System of Maritime Buoyage. The evils of the present unconformity of maritime signals have long been recognised and deplored, and conferences have been held from time to time in the hope of securing the adoption of a common standard and a universal system. Hitherto, these attempts have not been successful, for a variety of reasons, principally in that, so far as some countries are concerned, the step would involve changes too drastic in the character of the signals to which their nationals have become accustomed. Under the auspices of the League of Nations, however, a fresh attempt has recently been made at Geneva, where an agreement was signed on May 13th last, by the representatives of thirteen countries, comprising, in addition to Great Britain, Belgium, India, China, Estonia, Finland, Latvia, Morocco, Monaco, Sweden, Tunis, Turkey and the Soviet Republics. The omissions from this list are, it must be admitted, important and significant. France, the United States, Germany and Italy, not to mention other countries, represent abstentions which deprive the Agreement of no inconsiderable degree of weight and influence. Still, in so far as it goes, the proposed system is a step forward, and, in course of time, it may be hoped that more general agreement will be secured.

The full display of diagrams to be found in the Blue Book is too complex in colour characteristics for inclusion in these columns, but there will be found reproduced on another page a diagram showing types of marks as defined in the rules which, as stated above, are printed in the Blue Book, the price of which is 1s. 3d. net.

It may be added that the rules are based on two systems of buoyage, the Lateral and the Cardinal. The former is generally used for well-defined channels, buoyage-marks indicating the position of dangers in relation to the route to be followed by mariners in the vicinity. The Cardinal system is used to indicate dangers in cases where the coast is flanked by numerous islands, rocks and shoals, as well as to point out dangers in the open sea. In this system the (true) bearing of the mark from the danger is indicated to the nearest cardinal point. One or other of both systems may be used in the same country, according to preference or local requirements, provided that the limits of their respective use are clearly shown on nautical documents and, if necessary, by appropriate marks.

It is to be noted that the Agreement remains to be ratified by the respective governments concerned, and that it does not enter into force until the ninetieth day following its definitive acceptance by ten governments.

Atlantic Greyhounds.

The possibilities—we hesitate to say the practicabilities—of ocean travel in the proximate future, as outlined in the remarkably imaginative and suggestive paper read before the Institute of Marine Engineers on December 15th by Monsieur Pierre de Malglaive and Mr. A. C. Hardy, are matters for the consideration of the naval architect, the shipbuilder and the shipowner rather than for that of the port authority, and in so far as questions of speed, stream-lining, fuel consumption and horizontal exhaust ducts are concerned, we may not venture to intrude our inexpert comments upon them. But in one respect the joint authors made a direct reference to the sphere of operations ashore, which, in our view, certainly merits the attention of port officials.

They pointed out that it was incongruous (they might justifiably have said, absurd) that ships should be pushed to the utmost limit of their propelling power to obtain an increase in speed in the voyage across the Atlantic at great expense to their owners with the object of saving a few hours of crossing time, if that exiguous and precious economy is to be frittered away in needless and vexatious delays on arrival, through routine formalities prior to disembarkation, and Customs examinations requirements before passengers are free to leave the quay.

They alluded to a scheme put forward many years ago on the other side of the Atlantic for providing docking facilities at Montauk Bay, Long Island, from a position near which point to a Manhattan pier at New York, express liners take nearly ten hours, and they claimed that merely by the exercise of reasonable expedition in arrival procedure at the nearest place of landing, nearly a full day could be saved in the schedule of a vessel's passage time.

Whether this be an accurate statement or not, and whether the authors' suggestions for curtailing delays are possible or the reverse, the fact remains that landing arrangements on both sides of the Atlantic admit of a considerable degree of acceleration, and we would invite the attention of the Customs and Port Medical Authorities, as well as that of the Steamship Companies, to the opportunities which present themselves for improvement in this respect. In common with others, we ourselves have experienced the vexatious and irritating loss of time involved in complying with Customs regulations, in passport inspection and baggage examination, and we are of opinion that the authors are fully justified in their strictures on the present order of things.

On this side of the Atlantic the authors suggest port terminals in Cornwall and Brittany connected with the capitals of their respective countries by express train services. Attempts have been made in the past to promote a landing point at St. Just, near Falmouth, where harbourage facilities are a natural feature, but the heavy cost of quayage construction with port equipment and rail connections, has proved a deterrent to the investment of capital in an undertaking which would require considerably more financial support than the dues arising from the intermittent calls of fast liners.

To cross the Atlantic in an 84-hour quay-to-quay trip may perhaps be a visionary conception at the moment, but if effective competition with air transport is to be maintained in the not distant future, some such ideal will have to be present in the minds of those who wish to retain for their fleets the popularity which sea surface travel has enjoyed in the past.

River Conservancy Responsibilities.

The navigation of the Humber has always been a matter of some uncertainty and difficulty, on account of the instability of the ship channel, which has a regrettable propensity to wander at will from one side of the estuary to the other. In May last, we published a diagram showing how twice within the space of twelve months it had moved across from the Lincolnshire coast to the Yorkshire coast and back again. With this fact in mind, our readers would scarcely be surprised at the fate which overtook the unfortunate "Neptun" on June 27th last year. Despite the attention given by the Humber Conservancy Board to the demarcation of the channel by moving the lightship at Middle Whitton to suit the changing conditions and by issuing the necessary notification to mariners, the vessel under the charge of a pilot, while coming down from Goole, went aground, broke her back and became a total loss.

The allocation of responsibility for the stranding has been the subject of a legal action, which is reported and commented upon by our Legal Correspondent in another page. We do not propose to discuss the legal technicalities of the case, but it is important to draw the attention of our readers to the duties and obligations of a Conservancy Board as laid down in his judgment by Mr. Justice Langton, with the collaboration of the two Elder Brethren of Trinity House who assisted him in hearing the case.

It is to be noted that, having received their powers by virtue of transfer from the former Hull Trinity House, the duties and responsibilities arising out of the exercise of these powers, which are ancient in origin, were not expressly defined. Common sense would, of course, suggest that a buoyage authority must essentially guarantee the safety for shipping of the course which it indicates by the placing of buoys and lightships, but, even so, there are limits to the knowledge and prescience of those in charge, especially under the changing conditions of the locality. Having, therefore, done all that was humanly possible under circumstances which were admittedly difficult, and having exercised that reasonable degree of care which is the ultimate extent of serviceable duty, it was held that no ground for a claim of damages existed against the Conservancy Board—a decision which will commend itself to our readers with, in the case of river authorities, a definite feeling of relief.

Thames Barrage Inquiry.

The following notification has been issued:

The Port of London Authority, having agreed to a Public Inquiry being held upon the proposal to construct a barrage across the River Thames within the Port of London, have appointed, on the nomination of the President of the Institution of Civil Engineers, Sir Henry Maybury, G.B.E., K.C.M.G., C.B., M.Inst.C.E., to hold the Inquiry. He will have as navigational assessor Capt. A. H. Ryley, who has been appointed by the Board of Trinity House on the nomination of the Deputy Master.

The Inquiry will be opened at 10.30 a.m. on 29th March, 1938, at the Offices of the Port of London Authority, Trinity Square, E.C.3.

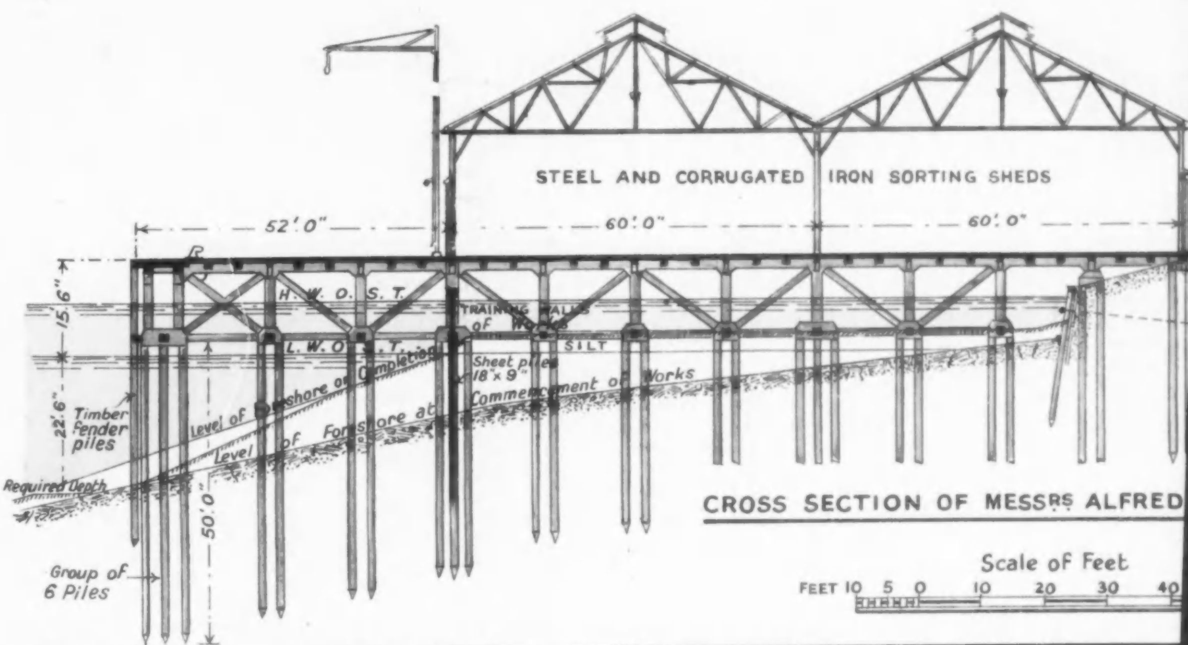
Persons desirous of submitting at the Inquiry proposals for the construction of a barrage must deposit with the Secretary of the Port of London Authority on or before 31st January next, plans and sections fully descriptive of the works proposed, drawn to a scale of six inches to the mile.

Any plans and sections so submitted may be inspected at the Offices of the Port Authority on and after the 1st February next, between the hours of 10 a.m. and 5 p.m. from Mondays to Fridays inclusive, and from 10 a.m. to 12 noon on Saturdays.

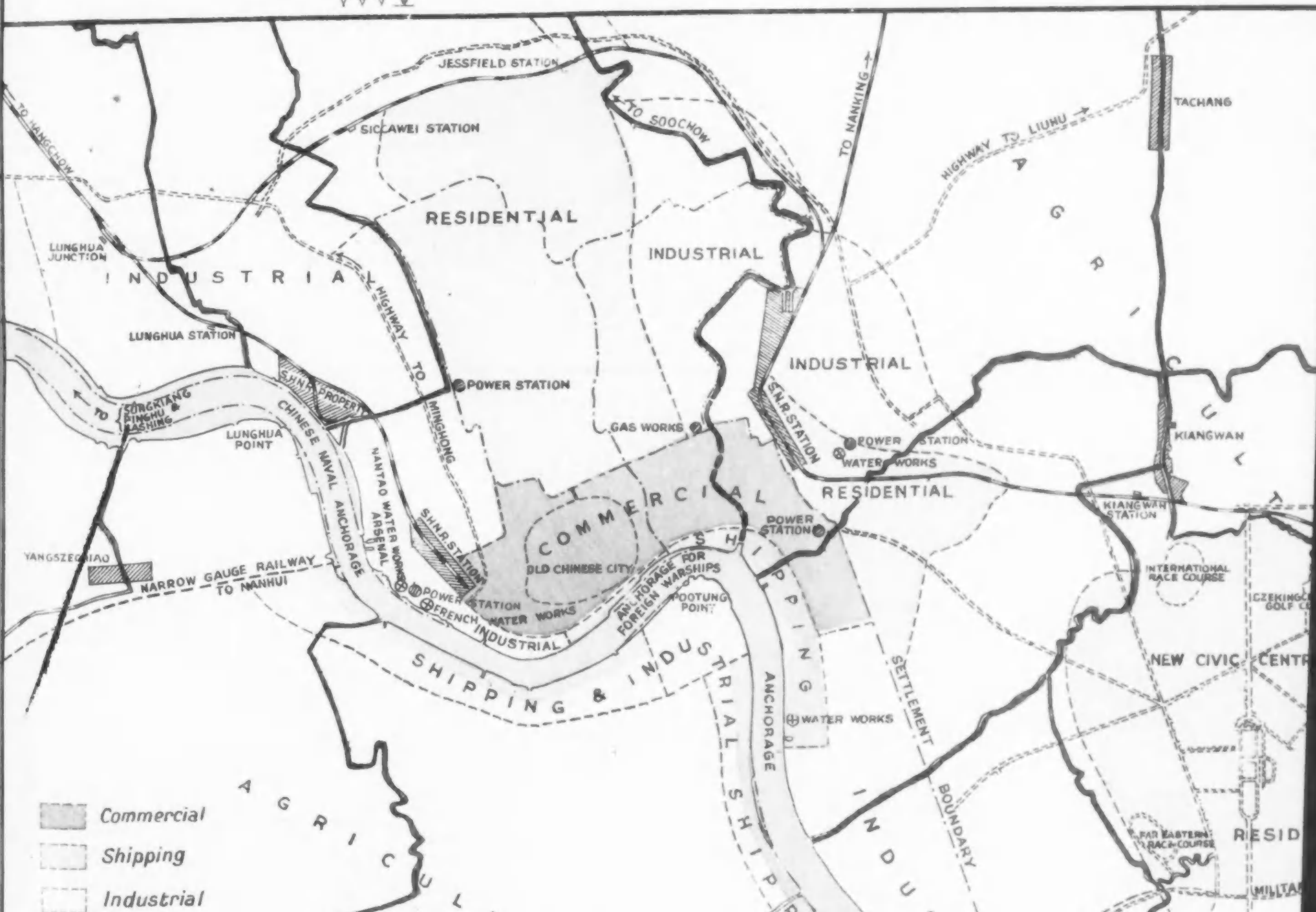
Persons desirous of giving evidence at the Inquiry may be heard personally or by Counsel, Solicitor or other Agent.

PORT OF SHANGH[A]

UNDER THE JURISDICTION OF THE WHANGPOO CONSERVANCY BOAR[D]



CROSS SECTION OF MESSRS ALFRED



REGIONAL DEVELOPMENT OF SHANGHAI.

WARD & FOXLOW LITH

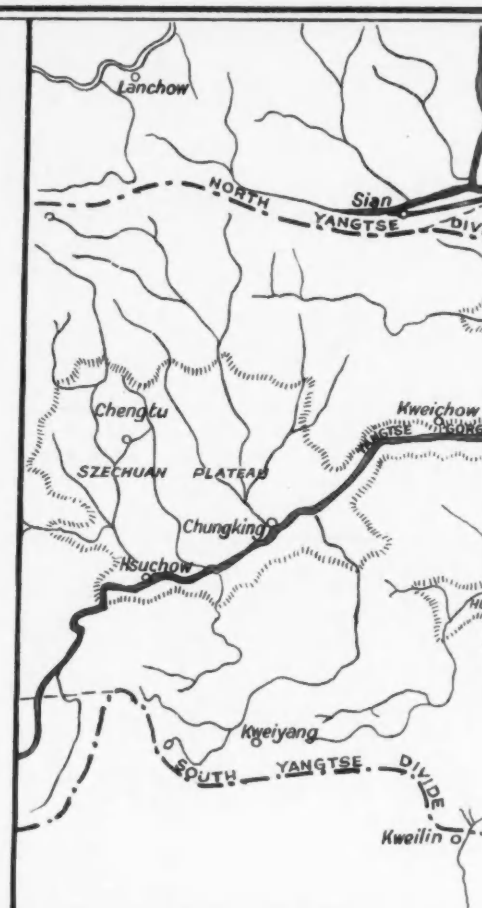
K AND HARBOUR AUTHORITY, JANUARY, 193

GHAI.

Y BOARD.

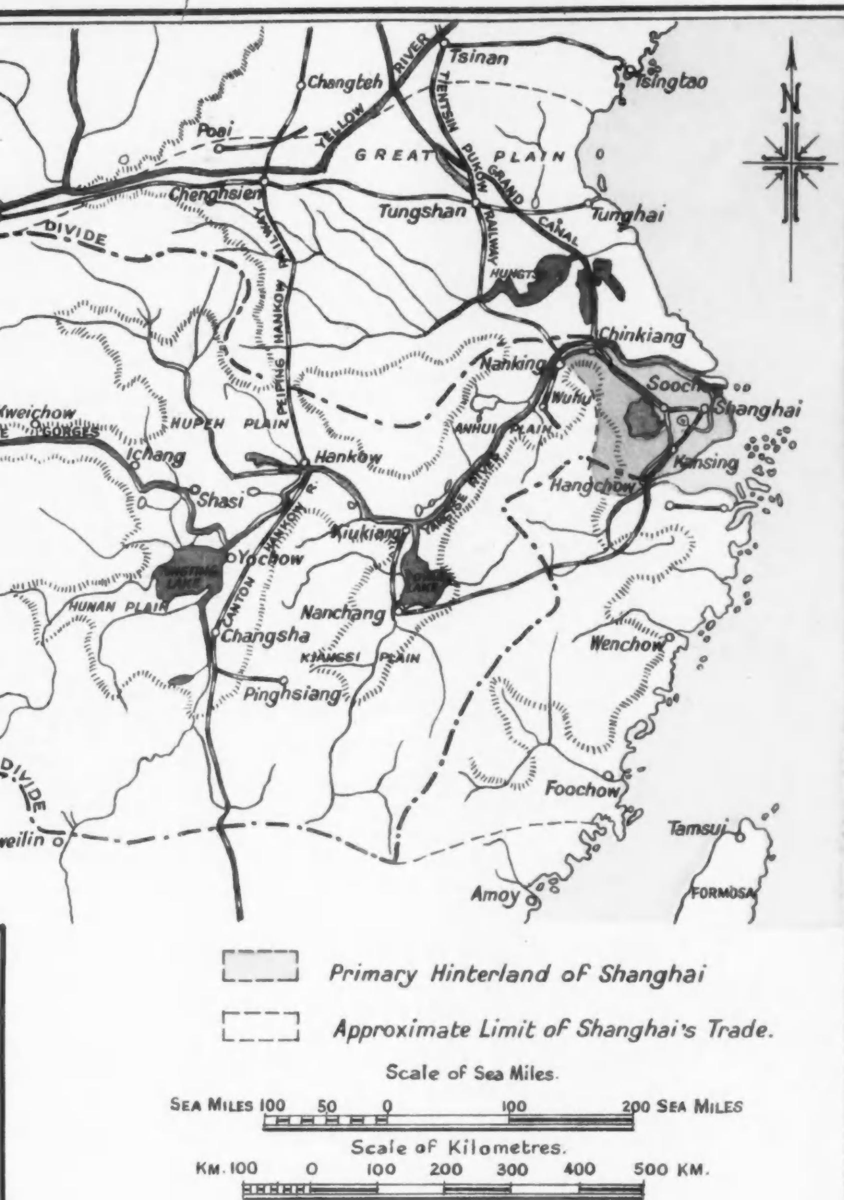
RS ALFRED HOLT & CO'S WHARF.

of Feet
0 30 40 50 FEET

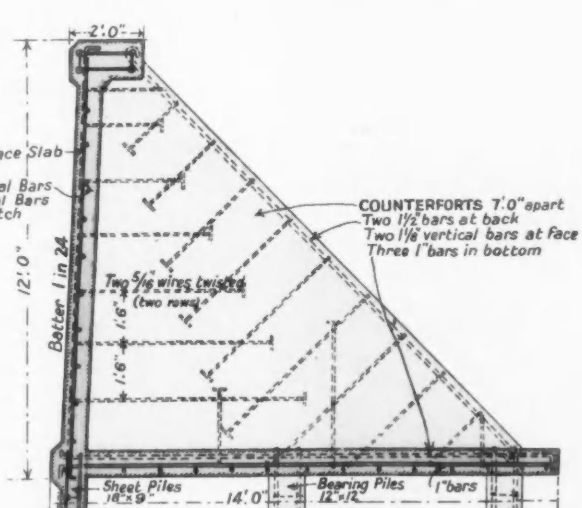


FOXLOW LITH HARCOURT STREET MARYLEBONE, W

Y, 1938.



INLAND COMMUNICATIONS OF SHANGHAI.



CROSS SECTION SHEWING QUAY WALL REINFORCEMENT.

MESSRS ALFRED HOLT & COS WHARF.

Scale of Feet.

INCHES 12 6 0 1 2 3 4 5 10 15 FEET

Tho River Front (The Bund), Shanghai.

The Port of Shanghai

By C. A. MIDDLETON SMITH, M.Sc., M.I.Mech.E., Taikoo Professor of Engineering in the University of Hong Kong

SHANGHAI is the premier port of China, through which more than half of the foreign trade of the country passes. It could not have so developed but for the many improvements made in its harbour facilities during the last fifty or sixty years. It is now the commercial metropolis of China, containing a cosmopolitan population of over three millions, and although the vast majority of the people in Shanghai are Chinese, yet almost every nation on the earth is represented. Amongst the millions of Chinese are natives from all of the provinces of China, a land of one written script but of many local dialects. English is now, almost invariably, the language of foreign trade in the Far East, and it is not uncommon for Chinese in Shanghai from different districts to communicate with each other in the English language.

A panoramic view of a portion of the harbour is shown above, in which the main features are the modern buildings in the International Settlement. On the Supplement will be found maps of the country around Shanghai.

The geographical position of Shanghai makes it the distributing port for the commerce of a rich and densely-populated area of China. There is no other port in the world that has a population of the same volume and density, depending for its commercial intercourse with other nations upon facilities for navigation provided by the port authorities. Waterways from Shanghai spread, not only westward across the whole width of China, but throughout the vast alluvial plain of the Yangtze basin, which maintains a population of more than one-tenth of the inhabitants of the whole world. Beyond the Yangtze basin there are navigable rivers and canals forming a net-work of inland communications as far north as Peking and as far south as the borders of Kwangtung province. For centuries there has been water transport from Canton in the South, to Peking in the North—about 1,400 miles—except for a gap of about 30 miles over a mountain track where coolies carried goods in transit between the two cities. So that although Shanghai is the port of foreign trade for practically the whole of the huge Yangtze basin, with 160 million inhabitants, it also serves many other centres of a land containing over 400 million people.

Of the total of 143,978,837 tonnage of powered vessels that entered and cleared in the ports of China, in 1935, the British headed the list with 60,112,641 tons; the Chinese had a total of 41,955,283 tons, and the Japanese a total of 21,919,100 tons. Over 25 per cent. of this traffic was to or from Shanghai.

HERBERT CHATLEY, D.Sc. (Engineering), M.Inst.C.E., M.Inst.C.E. (Ireland), Engineer-in-Chief Whangpoo Conservancy Board, 1925-1937, Consulting Engineer, 1937

The Whangpoo Conservancy Board

The harbour of Shanghai presents one of the best examples in the world of the triumph of man over obstacles formed by Nature. It is the lower channel of the Whangpoo River, about 21 sea miles long. It is entirely due to the practical work, and researches, of harbour engineers that large ocean-going vessels now navigate the Whangpoo River from Woosung to the Shanghai Wharves, and also the approaches from the sea, and along the mouth of the Yangtze River up to Woosung, at the entrance of the Whangpoo River.

The Whangpoo Conservancy Board consists of a nominee of the Ministry for foreign affairs (Chinese), the Commissioner of Customs in Shanghai (foreign), and the Harbour Master (foreign). The principal officer is the Engineer-in-Chief, until quite recently, Dr. Herbert Chatley, M.Inst.C.E., whose services are now retained as Consulting Engineer. The Board's funds are derived from a special tax on trade collected by the Shanghai Customs.

The Two Waterways

In order to appreciate the difficulties that have been overcome in providing a safe channel for ocean liners using the port, it should be explained that work had to be done in two waterways, viz., the Whangpoo River and the mouth of the Yangtze. In both channels there were bars that did not affect native junks, nor cause any great inconvenience to foreign ships in the early days of trade in the middle of the 19th century, but in recent years the accumulation of silt, and the increase in total tonnage and in the size of ships, have introduced great complications which have made extensive dredging and training operations imperative.

After the Taiping rebellion (1854) and the signing of a peace treaty between China, Britain and France in 1861, the Chinese Customs Service was organised more or less on its present system, mainly by British officials. In recent years the Chinese Government has assumed greater control, and now fixes all tariffs. Sir Robert Hart, Inspector General of the Customs Service, formulated a scheme for a Marine Department soon after his appointment in 1862, arranging for lighthouses to be built on the coast, and for inland navigation, buoys and beacons to be set in the approaches of harbours; also pilot services for the several Treaty Ports were inaugurated. Conservancy operations were initiated by the Customs officials, but in the case of Shanghai no large measures were taken until 1905.

Port of Shanghai—continued

The Whangpoo Bars

Hydrographic surveys of the Shanghai channels were undertaken by the British Admiralty, until the Customs Service published their own charts, when the British surveying vessels were withdrawn. The Whangpoo Conservancy and the Chinese Admiralty now do this work. Harbour and conservancy matters were closely studied and, in conjunction with Siccawei Observatory in Shanghai, the Customs' Marine Department kept track of changing channels, marking them, and issuing notices to mariners as they do to-day.

There were two bars in the Whangpoo River, one near the mouth (the Outer Bar) and one about three miles up (the Inner Bar) where the channel was split by an island (Gough Island). From time to time shipping found difficulties at the bars, and as the result of the many representations made to induce the authorities to regulate the channed, and after the Boxer troubles, they agreed to do so, and eventually a Dutch engineer, de Rijke, was appointed in 1905 to eliminate the Inner Bar and deepen the Outer Bar.

The systematic work began with the formation of what was called the Whangpoo River Conservancy in 1905.

After four years of work the notorious Woosung Inner Bar no longer existed, and the Outer Bar was much improved. When the contract with de Rijke expired in 1910, Von Heidenstam, a Swede, was appointed as engineer.

During the last thirty years the whole length of the Whangpoo River, from Woosung to the Arsenal, a length exceeding 20 miles, has been canalised. A regular channel has been formed with smooth curves and gently tapering shores. The contrast between the state of the river in 1906 and 1935 is shown clearly in the diagrams on page 69. The area marked "Gough Island" has been united to the shore and increased in size by reclamations, the former channel ("Ship Channel") behind it has been filled in, and the old Junk Channel dredged to form the newer Astraea Channel. The Outer Bar was improved by a convex training wall. There is now a navigable depth of 28-ft. at low water of ordinary spring tide.

The Chinese Maritime Customs House and Offices of the Engineer-in-Chief, Shanghai.

The Soochow creek, which connects Shanghai to the Grand Canal of China (800 miles in length), had been silting up badly for many years, and to make a clear channel for lighters, the Whangpoo Conservancy Board dredged the mouth for a distance of about 13 miles upstream. Work commenced in 1931, and by June, 1936, some 1,500,000 cubic yards (1,500,000 tons) of mud had been removed. Both shores of the creek have been intensely developed along the lower seven miles, and flour, siik, cotton and other mills have been built, supply and delivery of goods being made by lighter.

An international Committee of Consulting Engineers, composed of harbour specialists, was appointed in 1921 to consider all technical port problems. The Committee consisted of the following experts:—

(1) General Black, formerly Chief of the U.S.A. Army Engineering Corps; (2) Dr. Hiroi, the adviser to the Japanese ports; (3) Mr. P. G. Hornell, Consulting Harbour Engineer (nominated by the Chinese General Chamber of Commerce); (4) Mr. F. Palmer (afterwards Sir Frederick Palmer, K.C.M.G.), Consulting Engineer to Port of London; (5) Mr. L. Perrier, a former Chief Engineer of the Suez Canal; (6) Mr. P. J. Ott de Vries, a distinguished Dutch expert on harbours, together with the Board's Engineer-in-Chief.

C. P. HSUEH, M.S. (M.I.T.), Assoc.M.Am.Soc.C.E., Appointed Engineer-in-Chief Whangpoo Conservancy Board in April, 1937.

In their Report, which was published in the June 1922 issue of this Journal, they advised the port authorities that a draft of 33-ft. would probably be required to accommodate larger vessels, and stressed the fact that their recommendations were commercially sound. They proposed to raise funds by means of Port Debentures of nearly $15 million (silver) dollars.

The latest returns (1935) show about 17 million tons of shipping entered at Shanghai; the port is high on the list that gives the tonnage entered recently in the leading ports of the world.

The outstanding geographical, geological, commercial, and even political, facts concerning Shanghai are intimately connected with China's giant river, about 3,200 miles long, the Yangtze Kiang. Geologists declare that, long ages ago, a great Asiatic Mediterranean Sea covered what is now Central China, penetrating more than a thousand miles inland from the present coast line. Into that sea flowed the Yangtze. It leaves the hilly country at Ichang; the great alluvial plain, across which the main river, about 1,000 miles in length from Ichang to the sea, winds its way, is as much a child of the river as is the deltaic land more recently deposited around Shanghai.

The Yangtze rises amongst mountains 17,000-ft. high in Tibet, and has a strong current in a channel 750-ft. wide, some 3,000 miles from its mouth. From its source, to about 1,600 miles from the sea, it falls from 17,000-ft. to about 800-ft. above sea level—an average slope in the river bed of $9\frac{1}{2}$-ft. per mile. The discharge into the sea averages 1,000,000 cubic feet of water per second. The maximum discharge is nearly 3,000,000 cubic feet per second.

Mr. Von Heidenstam estimated that 15,000 square miles of delta land were laid down by the Yangtze in 10,000 years. This is an average rate of $1\frac{1}{2}$ miles per annum. He gave the average height of the Yangtze delta as from 12-ft. to 15-ft. above sea level. The area of the delta is nearly 50,000 sq. miles, and supports a population of over forty million people, and behind it is the Yangtze basin with a further 120 million inhabitants.

Authentic Chinese records, that go back nearly 2,000 years, give evidence of the many changes that, in those times, had taken place in the direction and volume of the waterways around the delta in which Shanghai is situated. Shanghai is not men-

Port of Shanghai—continued

tioned in the early records, and even the native city is only about 1,000 years old.

Geological and geographical facts give some idea of the practical problem of the conservation of the Whangpoo River and its outlet into the mouth of the Yangtze. It is upon the maintenance of the channel to the sea that the present and future prosperity of Shanghai as a port depends.

The Silt Deposits

It is not the discharge of the Whangpoo that maintains a navigable channel, though its aid is important. Rather it is the inflow of tidal water from the Yangtze, together with the scouring effect of the combined outflow. A full spring tidal influx amounts to 4,400,000,000 cubic ft. of water, while the volume discharged by the same tide is 5,000,000,000 cubic ft. Thus the contribution of the drainage basin of the Whangpoo amounts to 600,000,000 cubic ft. per tide.

The silt in the Whangpoo comes mainly from the Yangtze, the water having silt content which is at a maximum about 500 parts per million at spring tides.

The Yangtze brings down 500,000,000 tons of solid matter each year, the area covered being about 30,000 sq. miles. Much of the silt is discharged into the Pacific Ocean in a very finely divided state.

P. N. FAWCETT, M.Inst.C.E., M.Am.Soc.C.E., Technical Adviser Whangpoo Conservancy Board.

Early History

It was not until A.D. 1075, nine years after the Norman Conquest of England, that Shanghai had established itself. It was then known as Shanghai-chen (or market). Later native writers called it the "City of Reeds."

It was not of much importance until about A.D. 1554, for before that date it was unwalled. There was then a need for protection, as Japanese raiders—and probably Chinese pirates—levied tribute. But the real history of Shanghai commenced with the arrival of the British fleet of steamers, warships, transports, and the survey vessel "Blenheim," at the mouth of the Yangtze in 1842. Soon after that event Shanghai was occupied by the British forces. Immediately British naval survey vessels obtained data about the channels around the port. The city was only occupied by British troops for four days, but the British naval surveys continued for some years until the Chinese Maritime Service continued the work.

The object of the British was not war, but trade, the soldier being quickly replaced by the Consul, and the men-of-war by the ships of commerce.

One of the earliest acts of the first British Consul was the delimitation, with the Chinese authorities, of the limits of the port and the dimensions of the anchorage. The first was 13 miles long, from the city to the mouth of the Whangpoo at Woosung. The latter was 3,000-ft. long, 1,700-ft. broad, leaving a junk passage of from 600 to 800-ft. wide.

British Interests in Shanghai

In spite of the sharing by the British pioneers in Shanghai of their rights with other nationals, the evolution of the now famous International Settlement has always been mainly due to the enterprise and initiative of the British residents. They have owned much of the land in the International Settlement—once a mere mudbank, now a huge city built on reclamations—and they have controlled many of the chief commercial enterprises.

The premier position of the British flag in the China coast trade for many years, and the pioneer efforts of the British, in connection with power-driven vessels on the Yangtze, and other inland waterways, have also helped to place them in a key position, not only in the Municipal Government of the International Settlement of Shanghai, but also to influence the Maritime Customs and Conservancy and other schemes connected with the Port of Shanghai.

It soon became evident to the pioneers in Shanghai that close attention and much expert advice was needed for port and harbour works if foreign trade was to be developed as they desired. The problems have been solved as a result of great technical ability and clever administration.

The Approaches to Shanghai

The China Sea, off the mouth of the Yangtze River, is open towards the N. and E., with depths exceeding 10 fathoms at about 30 miles off the China coast. There are strong and rotary tide currents; but the route to Shanghai is open and well marked with lightships and lighted buoys.

There is a safe open roadstead off the entrance to the Whangpoo at Woosung for vessels that may not berth in the river at Shanghai. It has a length of some six miles available, with a width of from 1½ to 2 miles between the 30-ft. low-water contours. In the deepest channel near to the South side there is 50-ft. or more, the bottom consisting of mud or fine sand.

Vessels anchoring at Woosung use lighters for the transfer of cargo, which is then towed to Shanghai. When there is a strong wind, however, the transfer is difficult, and although there is no danger to large vessels properly anchored during rough weather, lightering becomes impossible and the safety of the lighter is endangered. It is estimated that lighterage is prevented about 20 per cent. of the time, and it is difficult to work both sides of a ship 50 per cent. of the time.

The Yangtze Estuary

The general authority on the Yangtze is the Yangtze River Commission. This Commission, which was inaugurated in 1922, has small funds and little experience, but is supervised by The Hydraulic Engineering Bureau of the National Economic Council. Its present activities are chiefly confined to surveying and giving advice to local authorities.

The Whangpoo Conservancy Board has been interested in the Yangtze Estuary since 1916, and the joint representatives of the Board and shipowners, from 1921 to 1930, finally induced the Executive Yuan of the Central Government of China to authorise the Board to dredge the great Yangtze Bar. Shanghai is the only place that is in the least degree interested in the Yangtze Bar, since any ship that is hindered by the present bar would be equally hindered by the crossings above Woosung before reaching ports higher up the Yangtze.

The purchase of a dredger costing over £151,000 in 1935, and the contract for what is probably the most powerful dredger in the world (costing £231,700), recently signed, is part of the effort to improve the channel in the Yangtze Estuary.

The Board's Work

Constant dredging is necessary in the Whangpoo in order to maintain a channel of sufficient width and depth to allow modern vessels to enter and leave the port. The enormous deposits of silt, not only in the channels, but especially at the bars, have made it imperative to purchase expensive equipment and to maintain a large staff at work on dredging operations. The results obtained have been remarkable and are of great interest to harbour engineers. The Chinese have willingly co-operated and, in recent years, well-trained Chinese engineers have taken an active part in the work. It is significant that an experienced Chinese engineer, Mr. C. P. Hsueh, has succeeded Dr. Chatley as Engineer-in-Chief of the Whangpoo Conservancy Board. Mr. P. N. Fawcett, formerly Engineer to the Liao River Conservancy, has also acted as Technical Adviser.

Since 1905 a large number of publications, containing a great deal of technical information, have been issued by the Board, while Dr. Herbert Chatley also contributed to various engineering societies, papers on many valuable researches and on the results of his experience in connection with conservancy problems. The following details have been obtained very largely from the above sources. To Dr. Chatley the writer is greatly indebted for the supply of publications etc.

The duties of the Board are to provide and maintain a deep channel from the sea to Shanghai, to undertake the new works necessary to improve the existing channel, and to help riparian owners in dredging in front of their wharves.

The Board, which has entire control of its funds and finances, derives its income from a Conservancy Surtax of three per cent. on the Shanghai Maritime Customs dues, one and a half per mile on duty free goods, 0.045 per cent. on treasure, and the proceeds from the sale of foreshore lands.

The Board's general jurisdiction extends to the tidal limits of the Whangpoo between high-water lines, and within these

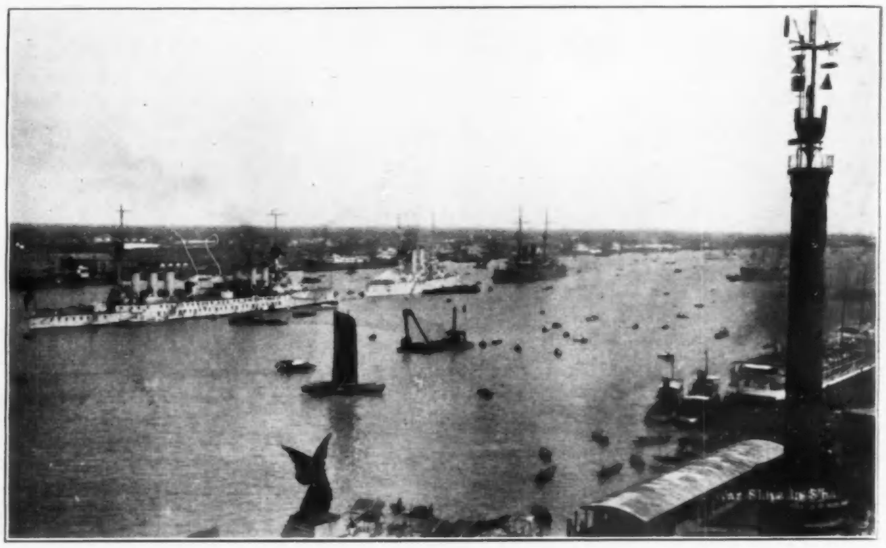
Port of Shanghai—*continued*

limits it may prevent any operation which would be harmful to the river. Its control of foreshore lands extends from the Kiangnan Arsenal to the Yangtze, and between the high-water lines of spring tide, as they were in the year 1906.

The Whangpoo Conservancy Consultative Board

The Consultative Board is an advisory body, consisting of six members, one member being appointed by the Chinese Chamber of Commerce, and the other five by the five nations having the greatest tonnage entering and clearing at Shanghai.

The duties of this Board are to watch conservancy proceedings on behalf of the commercial interests of Shanghai, both Chinese and foreign; to make representations to the Conservancy Board if they think it necessary; and if not satisfied to refer the matter to a Consular Committee for diplomatic settlement through the Ambassadors.



A View of the Whangpoo River at Shanghai (opposite French Bund).

The Whangpoo Problem

In 1905, when the work was commenced, the bar at the mouth of the river (Woosung Outer Bar) had a depth of only 15-ft. of water at the time of exraordinary low tides. Three miles up, the river divided into two channels, one very shallow of 8-ft. depth and only suitable for junk traffic, and the other with a bar having a depth of only 10 or 11-ft. at the recorded lowest low water (Woosung Inner Bar). From the upper end of the island, between these two channels, up to the International Settlement, the channel was wide, with shoals rising at several points. In the harbour itself the deep channel was too narrow; in two places the whole river was too narrow; and there was a bar commencing to rise at Wayside.

All these defects were becoming worse, so that it is certain that, unless regulation work had been undertaken Shanghai, by this time, would have become inaccessible to large ships. As it is cheaper to carry goods in large ships than in small ones, either the big ships would have gone to other ports or else they would have to unload into boats in the Yangtze. Whichever method was adopted, the cost would have been greater, and Shanghai would have suffered from the increased expense and probably still more from the diversion of business to other places.

The Whangpoo River is a drainage channel, whose basin extends to hills in the west, and is bounded by the Yangtze River in the north and north-east and by Hangchow Bay in the south and south-east. Except for the hill slopes at the Western watershed, and a few isolated hills, the channel is very little below the level of the plain. At the mouth, it is over 2,000-ft. wide, with a gradual narrowing above Shanghai to a system of lakes. For about 60 miles up from the mouth it is tidal, with a strong tidal scour. It has maintained a channel exceeding the dimensions required for the run-off, and so caused the river to meander and spread in the usual manner of rivers in alluvial plains, the result being a succession of pools and crossings and the bar at the entrance.

The difficulty has been to so regulate the channel to a normal width as to obtain a maximum and a fairly uniform depth, after making full use of tidal currents and other natural aids.

In 1906 the Conservancy laid down the normal lines within which the channel must be kept. These lines, which are the ultimate limits to which pier-heads, wharves and pontoons may be built, are about 1,400-ft. apart at the upper end of the harbour, gradually expanding to about 2,400-ft. at the mouth. They are also the ultimate legal limits for riparian landowners. Up to the end of 1935 a total of 56,620,000 cubic yards of mud have been dredged from the channel.

A comparison of the states of the channel in 1906 and 1935 (see next page), will enable the reader to realise the work carried out by the Conservancy Engineers during that period.

To guide the water between the normal lines, training walls of various types have been built in many places, with piles, brushwood-mattresses, caissons, stone, etc., etc., and where the channel was split by islands or shoals, one of the two branches—the Ship Channel—was closed by heavy dams, and the other one made into a first-class waterway.

In two places where the river was too narrow, it was widened by dredging.

Very large areas have been reclaimed by thus narrowing the whole channel, with the result that the deep channel is wider and the tidal currents run unimpeded from the Yangtze through the smooth gently-curving course. At the points where the land bulges out into the water the mud continues to settle, and at these places some 1,000,000 cubic yards have to be dredged each year.

The following is a general summary of the work that has been carried out by the three able Engineers-in-Chief, viz., de Rijke (1906-1910), von Heidenstam (1910-28), and Chatley (1928 to May, 1937). They are: (1) A training wall on the left bank at the mouth, one mile long, of heavy marine type. (2) The closure of the "Old Ship Channel" behind Gough Island, together with deepening the "Old Junk Channel," now called "Astraea Channel." (3) Training works at the mouth, to form a smooth trumpet form, joined to the shore of the Yangtze. (4) Various training works opposite Arsenal and below Pootung Point, etc., and numerous reclamations and buildings. (5) Dredging, exceeding 60 million cubic yards, practically all of which has been pumped to the shore. (6) Dredging the Soochow Creek (the principal tributary) in conjunction with the Shanghai City Government.

It is difficult to estimate in sterling the total cost of the Board's activities, on account of the great fluctuations in exchange values. It is given as 45 million silver dollars up to end of 1935, and £4,000,000 is probably a conservative estimate.

Continuous dredging of the Whangpoo is imperative. The Board aims to produce 30-ft. at lowest water over the bars.

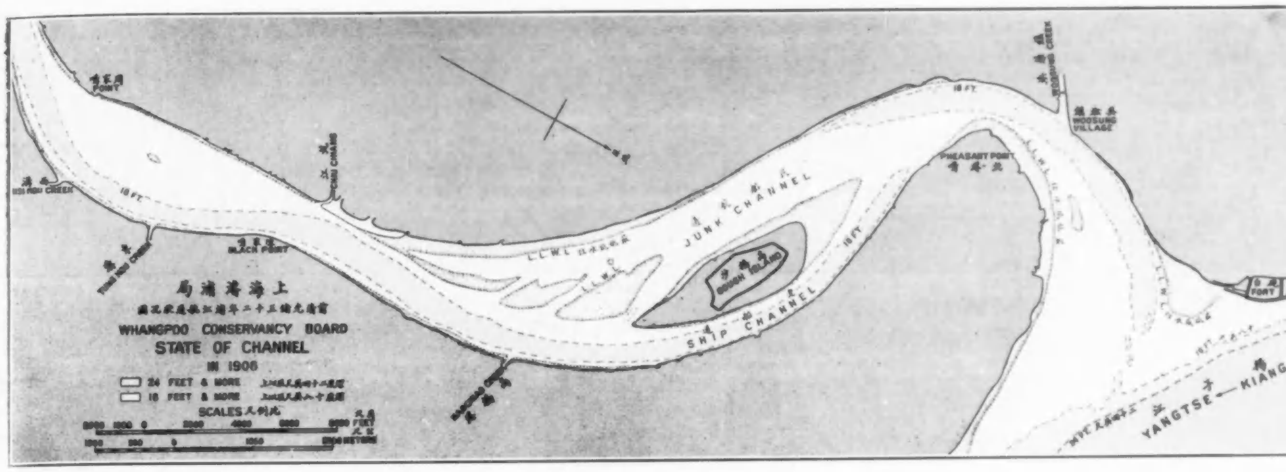
Thus the river was converted from an irregular, and rapidly deteriorating creek, into a good shipway with a least navigable depth of 26-ft. at extraordinary low water.

Loading a typical River Steamer with Coal.

Shanghai Harbour

The harbour has accommodated 156 merchant vessels and 22 warships, and

Port of Shanghai—*continued*



Whangpoo River in 1906.

about 500 junks at one time. The largest vessel was 657-ft. in length and had a 30-ft. draught, and could be berthed at a wharf or at a head-and-stern mooring.

Vessels up to 25-ft. draught can pass through the whole length of the harbour at extreme low water, and at high water vessels up to 32-ft. draught can be accommodated.

The area of the harbour between normal lines is about 4,810 acres, and between 18-ft. contours is 3,230 acres (approximately five square statute miles). There are eight main bends. Opposite the French Settlement is a low crossing and bar, and a sharp, narrow and deep right-handed turn (Pootung Point). Just below is the "Wayside bar," with 28-ft. at low water on the Shanghai side. There is then a long deep stretch (pool) on the right side extending almost to the Tung Kou Creek mouth.

There are eight creeks within harbour limits on the Shanghai side, Soochow Creek being the most important.

The highest speed of tidal flow (Flood, Spring) is 2.6 knots.

The frontage of the International Settlement above Soochow Creek consists of a public Bund, 3,500-ft. long, of which 500-ft. is a part of a Public Garden, and 3,000-ft. is used for discharging lighters and promenade.

The French Settlement Bund is 3,800-ft. in length, 3,170-ft. of which is a public quay, with public and private pontoons, and the remaining 630-ft. is public road with four public pontoons.

Ships are coaled almost entirely by hand labour from cargo boats or wharves, and practically all the loading and unloading is done by coolie labour, two exceptions being the Kailan Mining Administration and the Shanghai Power Co., who use mechanical apparatus.

There are eleven dry docks, varying in length on blocks from 640-ft. to 235-ft., giving a main average exceeding 400-ft. in length for the eleven. Five belong to "Shanghai Dockyards," three to the Chinese Government, two to small shipyards, and one to the Conservancy.

There are 68 head-and-stern mooring berths in the stream, including 4 naval berths, 4 berths for Customs cruisers, 2 berths for cable ships, and 3 berths for vessels with gasoline. Vessels may not moor with their own anchors in the harbour.

Wharfage dues are collected on all goods imported by vessels into Shanghai, or exported by vessels from that port. Goods transhipped at Shanghai or re-exported do not pay wharfage dues.

All the wharves in Shanghai are privately owned, so that berthing arrangements must be made with the owners. The provision of public wharves and piers was recommended by the 1921 Committee of Consulting Engineers, the estimated cost of the first stage being about 15 million (silver) dollars. The Central Bank has built a new public wharf ("Jukong Wharf" referred to below) which conforms to this scheme. The City Government of Greater Shanghai has started, in a small way, to provide public wharves, and has a large paper project near Woosung. Three experts from the League of Nations in 1932 disapproved of the wet-dock scheme included in the latter plan. There is ample opportunity for private riparian development, and this will probably take place.

The wharves of Shanghai are situated on both sides of the river, and accommodate both ocean liners and a large number of river steamers using the Yangtze and adjacent waterways.

The frontage served by pontoons totals 48,560-ft., of which about half is on Shanghai side of the river and half on Pootung side. There are 26,345-ft. of pile wharves, two-thirds on the Pootung shore. Bunding, without wharves or pontoons, is of about equal length on each side of the river, and totals 73,055-ft. The unimproved bank is of length 99,800-ft., half on each shore. The creek mouths frontage is about 2,500-ft. on each side of the river.

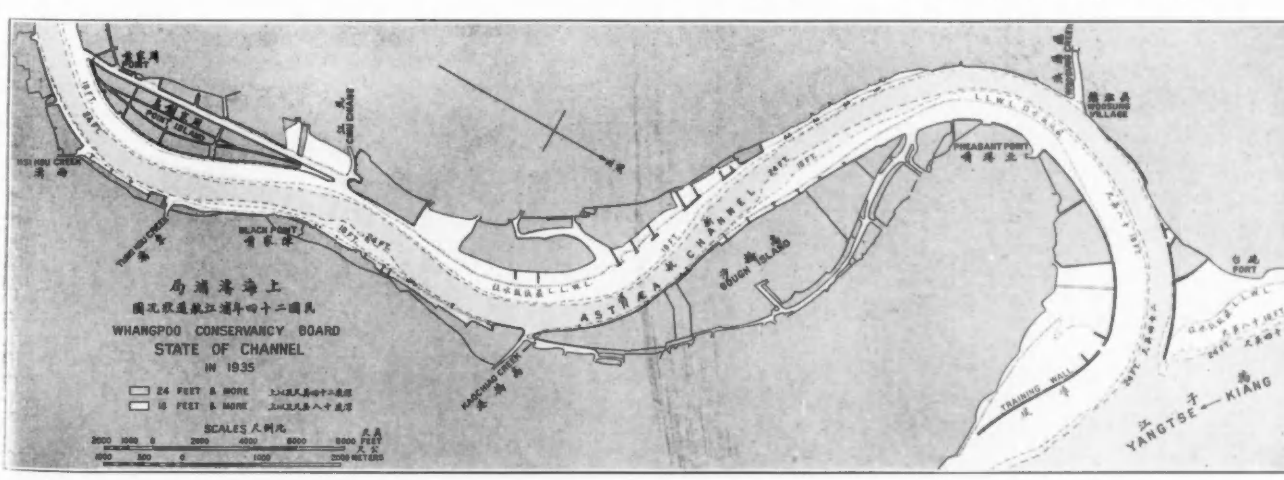
Of a total frontage of 253,475-ft., the British own 36,670-ft., the Japanese 23,615-ft., the Americans 13,730-ft., and the French 3,130-ft. The public frontage totals 87,290-ft., the privately-owned Chinese frontage is 36,670-ft., and a length of 87,290-ft. is given as undeveloped or agricultural.

Much of the cargo is handled by lighters from the outer side of ships at wharves, or moored in mid stream. The lighters moor in the shallower part of the harbour. There are 20 tug boats belonging to the lighter companies available for swinging and towing large vessels and for towing lighters. Chinese cargo boats are not usually towed but are worked by stern oars called "Yulohs." The harbour is deficient in mechanical equipment.

Shipyards and Docks

Vessels up to 14,000 tons dead-weight have been built in Shanghai, but the port does not excel Hong Kong in the matter of shipbuilding and ship repairing. There are a number of small Chinese yards that build launches and native crafts.

The Shanghai Dock and Engineering Co. has recently combined with the New Engineering and Shipbuilding Works, and



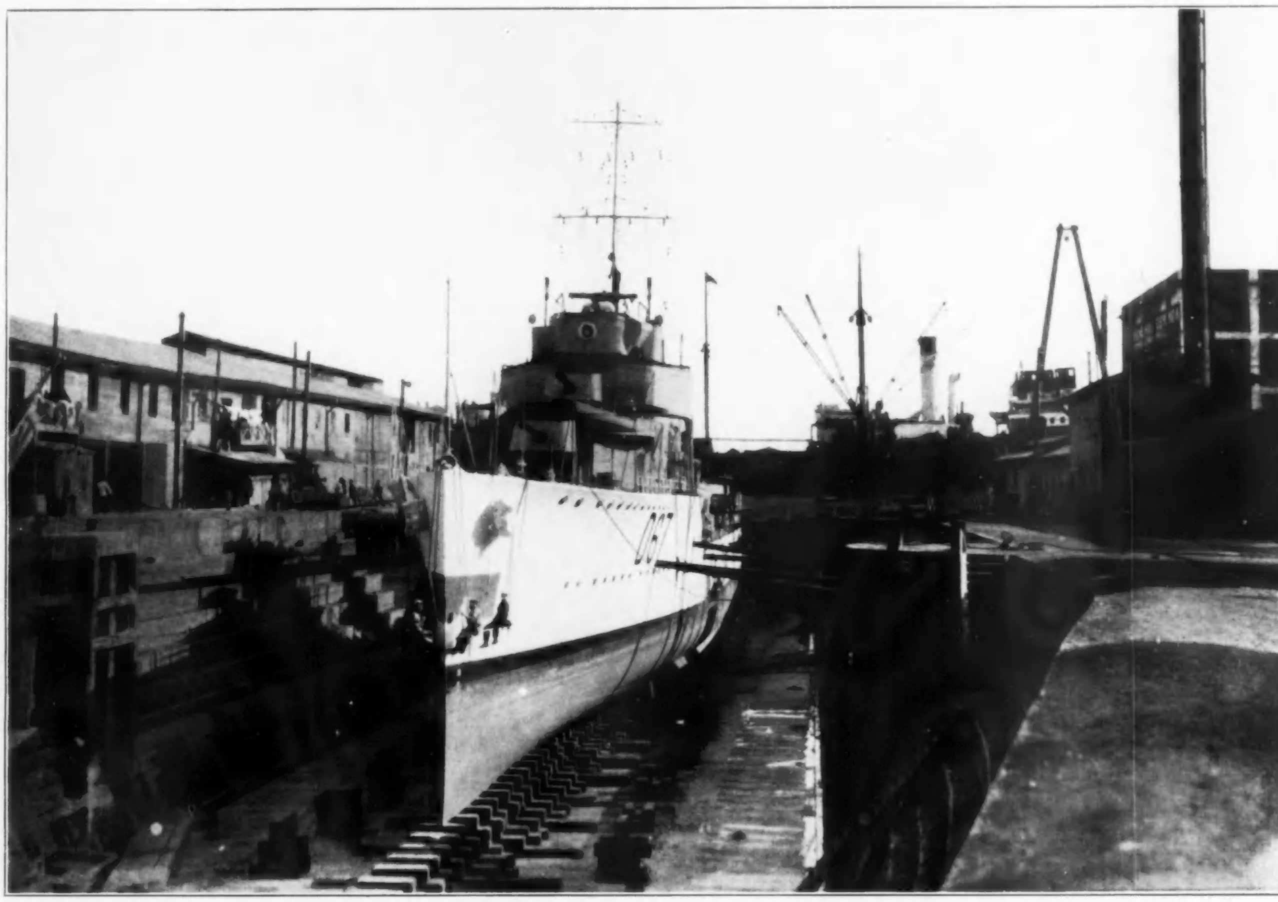
Whangpoo River in 1935.

Port of Shanghai—continued

is now known as "Shanghai Dockyards." This concern owns at present five dry docks. The longest length on blocks in one of these is 584-ft., with 62-ft. breadth at entrance and 20-ft. depth on sill.

The Chinese Government owns the Kiangnan Dock and Engineering Works. The dry dock with the longest length on blocks (640-ft.) has a breadth at entrance of 80-ft. and depth on sill of 23.5-ft.

The mechanical workshops of "Shanghai Dockyards" are well equipped. This firm easily takes the lead in this class of work for Central and North China. It is extremely well organised with a well-qualified foreign and Chinese staff. As Shanghai is not a terminal port on the Suez or Pacific routes, it follows that most of the repair work in Shanghai is either emergency or for the smaller vessels. The ships built ordinarily do not exceed 5,000 tons. It is probable that, as the Chinese develop their industries, Shanghai will become a more important shipbuilding and ship repair centre.



Shanghai Dockyards: Yangtzeepoo Dock No. 1.

The Jukong Wharf Construction

Dr. H. H. Kung, Finance Minister, organised a Planning Committee for the Jukong Wharf, the site of which is North of Jukong, and below Point Island Channel. The wharf is a part of the scheme to facilitate overseas shipping and to develop Greater Shanghai, and it is claimed that although the wharf is much below the commercial centre of Shanghai, a motor car will cover the distance in less than 20 minutes.

The first step in development was the reclamation of a very large area of low-lying fields, and the construction of two sections of reinforced concrete wharves, with warehouses, and other buildings. The estimated cost was 5 million dollars, financed by the Central Bank of China.

The Changing Trade of Shanghai

The general decline in trade in Shanghai in recent years was not entirely due to the situation in China. On the contrary when we consider the many adverse outside influences, more un favourable results might have been expected. The value of world trade was relatively in no better state, for in 1935 it was estimated at only 35% of that for the year 1929, but China's foreign trade for 1935 represented 55% of the figure recorded for 1929. And although China's adverse balance of trade in 1931 was 1,087 million dollars, in the following years it showed annual reductions of 132 millions, 222 millions, 238 millions and 152 millions of dollars. Thus, although the total value of trade declined, the adverse balance of payments was reduced by nearly 70% in the four years since 1931. That is the more remarkable as there has been a great decline in China's invisible exports in the form of remittances from overseas Chinese and foreign investments. Moreover, before 1931, there was a favourable balance of trade for the Province of Manchuria, now under Japanese control. The Manchurian trade was valued with a favourable balance on export account of about 190 million dollars. Shanghai trade was greatly affected by all these factors.

It is noticeable that since 1919 there have been great structural changes in China's import trade. Whereas in 1919 textiles accounted for 32.98%, the percentage was only 5.43 of the total in 1935. Machinery, vehicles, chemicals, mineral oils, etc., have each greatly increased in percentage value.

The enormous increase in textile mills and other power driven industries in Shanghai in recent years has resulted also in certain manufactured goods, which were formerly imported, now being exported from Shanghai.

The great demand for modern buildings, modern conveniences, such as plumbing, electric supply, radio, etc., has created a great change in the type of goods imported to Shanghai. Nor must we overlook the growth in national feeling which encourages local industries. The Chinese Government, through the newly-established National Economic Council, and with the help of foreign experts, is doing its utmost to increase the number of Chinese trained in applied science subjects abroad and in China. The reflection of all these new factors can be seen, each year in greater magnitude in Shanghai. The modern banking system, controlled by Chinese, the insurance and industrial companies, etc., are new features that record great changes. It should be mentioned, however, that the premier bank concerned with foreign trade is the Hong Kong and Shanghai Banking Corporation, whose directors are British. Also most of the important commercial firms concerned with trade in China are controlled by Europeans.

The fact that industrialisation in Shanghai, and the introduction of tariffs now enables her to manufacture goods formerly imported, has caused foreign firms to establish factories in the city to cultivate the import trade in heavy industries. It is in connection with the import of modern machinery, steel, vehicles, etc., that the foreign firms are now chiefly concerned. They are also doing their utmost to encourage improvements in farming, in flood prevention, river conservancy work, transport facilities (including not only roads and railways, but harbour facilities) and stabilised currency, in order to increase China's exports.

Editorial Note:—The foregoing article was written some months before the commencement of hostilities at Shanghai. Reliable information is not as yet forthcoming as to the destruction caused by gunfire and bombing, but the damage is known to be considerable.

The Manchester Ship Canal*

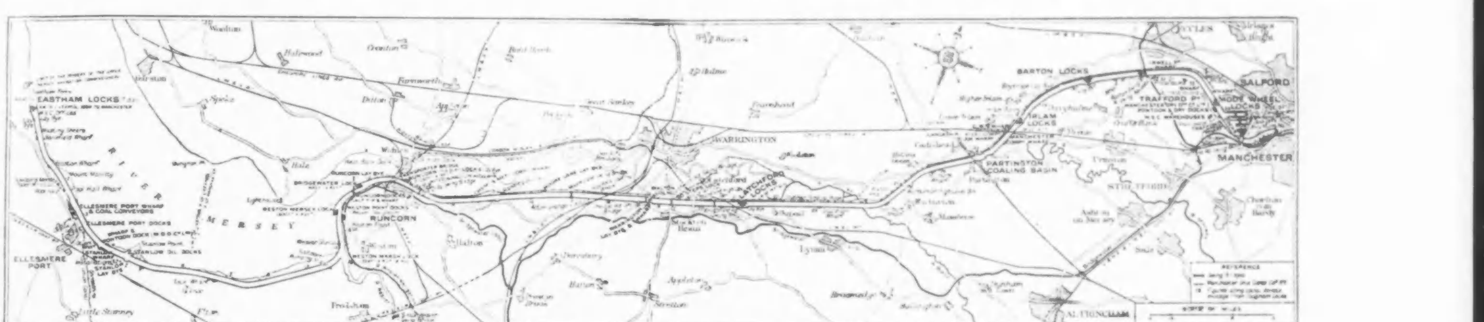
By *Vice-Admiral Sir PERCY DOUGLAS, K.C.B., C.M.G.*

MANCHESTER, thanks to its Ship Canal, ranks as a leading port of the United Kingdom. Judged by the value of its seaborne trade it occupies fifth place. The official figures for 1934 (the latest recorded year) show its overseas trade to have exceeded £52,000,000.

Behind this matter-of-fact statement lie some of the most interesting chapters in its industrial history and a great story of human endeavour; for Manchester is an inland city over 30 miles, as the crow flies, from the seaboard and some 35 miles by river above Liverpool.

The Ship Canal, which connects Manchester with the sea, brings ocean-going vessels to within a mile or two of the centre of the city, and the construction of the Canal falls logically into place, as I hope to show, in the emergence of south-east Lancashire as the greatest manufacturing area and that part of the country which has contributed most to its industrial progress

As the geographical features and industrial history of this area are inextricably interwoven with the story of Manchester's efforts to improve its communications, it will, I hope, be of interest to you if I mention some old history, etc., before describing this great achievement—the Ship Canal.



Map of the Manchester Ship Canal.

By Industrial Lancashire is universally understood an area which occupies the south-eastern corner of the county, overflows into Northern Cheshire and crosses the border of the West Riding of Yorkshire. It is clearly delimited. Its boundaries north and east are the uplands of Rossendale Forest and the southern spur of the Pennines; on the south, the agricultural plains of Cheshire, and to the west, mosslands In early times the mosses were roadless and trade between Manchester and Liverpool, before the improvement of the river route, was dependent upon the pack-horse. There was no carriage road between Liverpool and Warrington up to 1700. Incidentally, the treacherous nature of this area added greatly to the difficulties and cost of constructing the Manchester—Liverpool railway a century ago.

The hills were more helpful. They pastured the sheep that started a great textile industry and their streams later turned the power-loom and provided lime-free water for bleaching and dyeing. Moreover, these hills provided on their westward slopes a humidity in which the new cotton industry was to flourish.

Around the uplands which cupped Manchester towards the north spread the spinning, weaving and processing of cotton cloth; Manchester, the pivotal position upon which the hill roads converged, conferred upon it the status of a commercial centre.

Some trade with Ireland by way of Liverpool, through which flax came to be returned woven into linen cloth, had encouraged interest in the possibility of through water-traffic and this interest was later stimulated by a growing trade with the West Indies, whose demands for "cottons" developed rapidly in the mid-eighteenth century.

Early Steps in Improvement of Waterway

Manchester stands at the junction of the Rivers Irk and Irwell. The latter joins the Mersey 6 or 7 miles west of the city, whence the Mersey, twisting and turning on itself winds its way to the estuary, past Liverpool, and so to the sea. To convert this fickle and sinuous waterway with too little water in summer and too much in winter into a useful and reliable servant of commerce occupied men's minds for generations.

In 1697 Liverpool merchants were agitating for it to be rendered navigable from Manchester to Warrington to accommodate a trade estimated then at 2,000 tons a year. In 1712 Thomas Steers, who constructed the first wet dock at Liverpool, short-circuited it in places and added six locks. In 1714 the Mersey and Irwell Navigation Company was formed to improve and control the whole route. The river proved intractable; the Company did not pay and after 50 years it was eventually taken over, for a song, by the Duke of Bridgewater who thereby gained its statutory rights and eliminated such competition with his new canal as it offered. The Duke, realising the unreliability of the river, had constructed, with the aid of James Brindley, an independent canal from Manchester to Runcorn, linking up with his Worsley Canal near Barton. This canal extending from Worsley to Runcorn on one level was an early example of the revolutionary principle expounded and developed by Brindley: that, contrary to accepted practice, canals are best constructed independent of riverways, save to draw water from them. The point is material here for the Ship Canal, constructed within living memory, for the greater part of its course ignores the riverway.

The Duke's canal was completed in 1774 and held the field unchallenged until the coming of the railway.

Growing trade and the success of inland navigations encouraged schemes for an artificial waterway capable of accommodating larger craft.

In 1824 there was a proposal for a canal from Manchester to the Dee, to take ships up to 400 tons. The scheme reached Parliament but was rejected—the first Manchester—Liverpool Railway Bill was thrown out in the same session! Fourteen years later Sir John Rennie, called in by Warrington to improve the upper Mersey estuary (which had then only 8 or 9-ft. of water) recommended a canalisation scheme and its extension to Manchester.

Railway transport, although speedy, was relatively expensive, and this new competition stimulated fresh interest in water carriage and between 1840 and 1845 several new proposals were put forward envisaging the through passage of ships of 400-600 tons.

It is not impossible that the successful voyage to Ceylon, by way of Cape Horn of the "Nemesis," a vessel drawing only $4\frac{1}{2}$-ft., encouraged a belief that something a little bigger than the Duke's canal would open up Manchester to world trade.

The last of these schemes, of rather the "company promoting" kind, fizzled out in doubtful fashion and no project was brought forward for the next two decades. Interest was renewed by the opening of the Suez Canal in 1869 and talk of cutting through the Isthmus of Panama. Discontent over railway freight rates had encouraged a revival of hope that some practical steps might be taken to afford Manchester's growing trade an independent and self-controlled outlet to its overseas markets.

There is little point to-day in recapitulating the heads under which Manchester set out its case for independence. The prodigious effort the city put into achieving its object is eloquent evidence of "grounds" and the benefits which have resulted not alone to Manchester traders, but to many other interests, including those opposed to the Canal are abundant justification.

Inception of the Canal Scheme

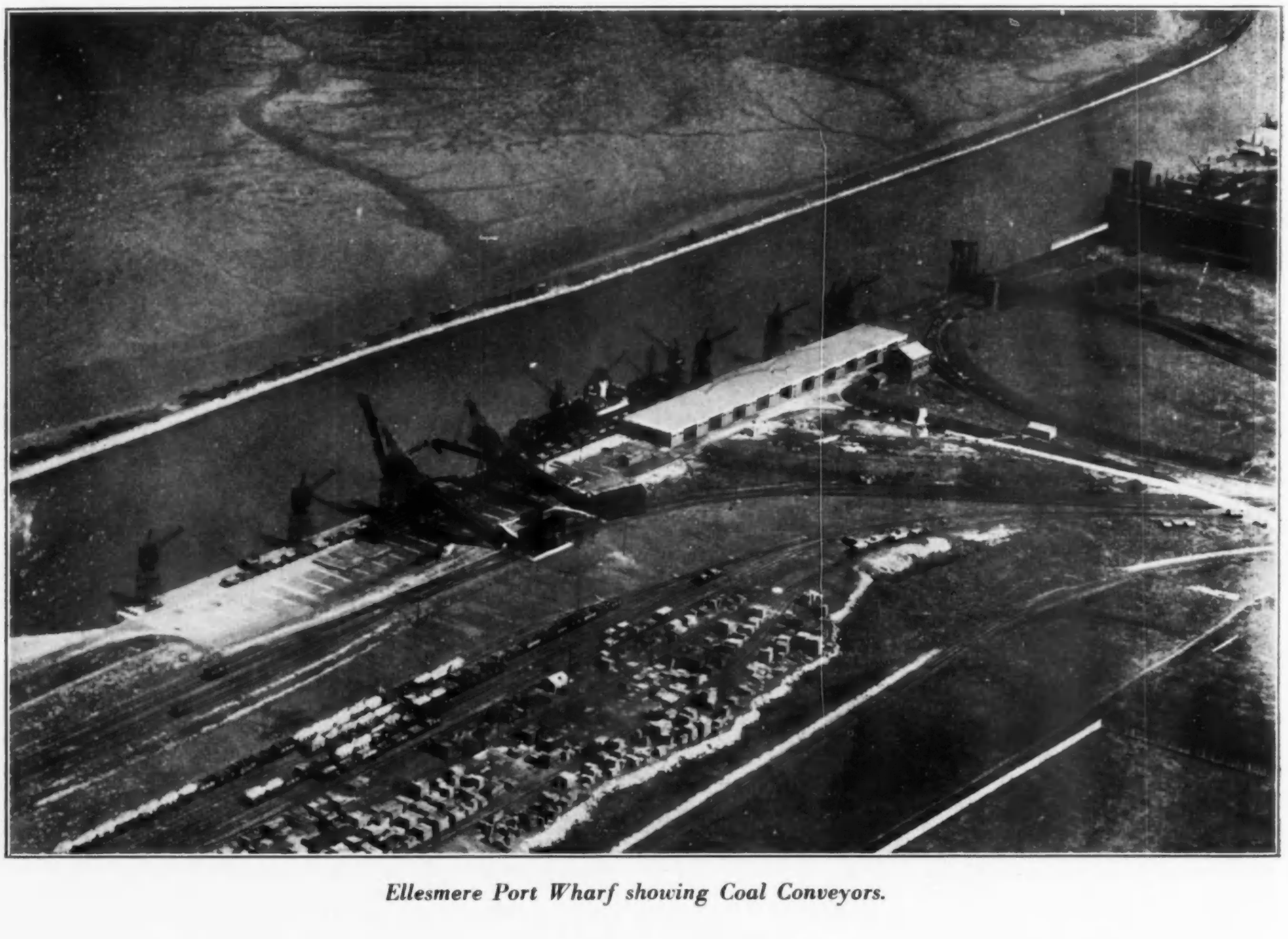
The 1870's saw the stage set for the most ambitious of all local canal schemes and that finally to be brought to fruition.

The latter half of the nineteenth century saw the metropolitan status of Manchester consolidated. The staple trade of the province for which the city is capital and market-place stands at the head of the British export trades. The industrial development of the area has branched out in countless new directions; the salt deposits of Cheshire no longer minister to the

* Paper read before the Royal Society of Arts on December 1st, 1937.

Manchester Ship Canal

Looking down No. 9 Dock at Manchester Docks.



Ellesmere Port Wharf showing Coal Conveyors.

Manchester Ship Canal—continued

cotton industry alone and machinery manufacture has extended far beyond the needs of the textile trades. Manchester and its surrounding towns have crept closer together until a degree of urbanisation has been reached comparable only with the capital and its environs, and the population of Manchester itself approaches the million mark. The results of the energy and resource with which Lancashire led the Industrial Revolution are apparent on every hand, but better communications are still sought. The agitation for a Ship Canal is renewed. There are letters and comments in the Press, Glasgow has improved in riverway, why should not Manchester do likewise. Mr. Hamilton Fulton, the engineer, encouraged by local fervour, prepared plans and models for a tidal waterway on a more ambitious scale than anything yet put forward.

The public exhibition of these aroused great interest and won the commendation of the Manchester Chamber of Commerce. Public interest languished after a while, but was whipped up by the circulation of figures showing the incidence of inland transport charges on Manchester imports. They were convincing and feeling ran high, but nothing was done until it became clear that nothing could be done without a leader. He was found in Daniel Adamson, a Manchester engineer, who placed himself at the head of the movement. A meeting of municipal representatives, manufacturers and merchants called at Adamson's house on the 27th of June, 1882, set up a provisional committee and everything was set fair for progress. Fulton's scheme for a completely tidal canal 22-ft. deep at low water and 37-ft. deep at high water was first adopted. Manchester being 93-ft. above the sea the docks were to be at a low level and served by underground railways. The channel was to follow the general line of the river and continue, between training walls, to the west of Warrington and from that point into the lower estuary. This scheme later gave way to one for a canal on three levels with the entrance locks at Warrington. In its turn this was replaced by Leader Williams' plan for a locked canal debouching at Runcorn. Williams' plan, later extended to Eastham, was that eventually adopted and that which I propose to describe in detail when I have covered, very briefly, the fight for Parliamentary authority and the raising of the necessary capital—a period of over five years.

Passage of the Act

By September Adamson's provisional committee had raised a guarantee fund and had decided to proceed. Conferences with trade organisations and local authorities were followed by mass meetings of citizens. The municipality approved the scheme, the Chamber of Commerce lent its support too, and parliamentary plans were deposited in November and the Bill in the following month. It was supported by over 300 petitions from public and private bodies, but met powerful opposition. It was thrown out—a second Bill suffered a similar fate.

In December, 1884, a third Bill was deposited. This time the Corporation of Manchester, which was helping to defray the expenses, was a joint supporter. The Royal Assent was given on 6th August, 1885. There are few better examples of doggedness than the way the promoters of the Ship Canal stuck to their guns. This fight lasted well over two-and-a-half years and cost the promoters over £170,000 in Parliamentary and other expenses and no doubt the opposition spent as much.

Succeeding Bills were powerfully opposed by vested interests of every kind; ranging from those whose duty it was to safeguard the navigation of the Mersey estuary and were properly concerned to resist anything which might add to their responsibility, to the owners of private amenities thought to be jeopardised by the proposed undertaking. Amongst the latter was the owner of a rookery, which he sought to maintain undisturbed.

Every riverine authority naturally looked for safeguards regarding their rights and privileges and innumerable clauses in the final Act provide for their vested rights in one form or another.

When Adamson and his colleagues returned from Westminster on the passing of the Act enthusiasm was intense. The city gave itself up to a period of rejoicing. There was processions of trade guilds, banquets and celebrations in which the mayors and corporations of Manchester and Salford paraded in full regalia.

Financial Difficulties

The next step was to find the money.

The early financial history of the Canal is exciting, and the difficulties encountered in the raising of capital caused a great deal of controversy. £8,000,000 was required. Was it right, people asked, that the workers should be allowed to risk their savings or, on the other hand, would corporations be justified in supporting private enterprise?

Adamson, with his dynamic character, expected everyone to share his faith in the immediate success of the enterprise. He expected that not only would the canal be justified as bringer of better trade but that it would pay substantial dividends. He, therefore, had no hesitation in appealing to working men to invest their small savings in the venture on patriotic and profitable grounds. Parliament made this difficult by fixing the shares at £10, which necessitated elaborate devices for collecting money in small sums.

Whilst Adamson's faith was infectious and large numbers of investors contributed small amounts the capital subscribed on these lines proved inadequate. A new orientation of policy was called for. Adamson vacated the chair in favour of Lord Egerton of Tatton, a kinsman of the Duke of Bridgewater, and in July, 1887, the firms of Barings and Rothschilds issued a new prospectus and the list of shareholders soon stood at 39,000. In November Lord Egerton cut the first sod on the site of Eastham Locks.

Unfortunately a number of disasters occurred in the form of landslides and floods and the discovery of quicksands. These adversities, the growing bill of legal costs and rising labour charges made unexpected demands upon capital.

Barton Swing Aqueduct, carrying the Bridgewater Barge Canal over the Manchester Ship Canal.

The attitude of the Corporation is illuminating. When promotion expenses were required it helped. When Adamson put forward the scheme as a remunerative investment strong voices were raised against the Corporation's participation on the grounds that public money should not be adventured in ordinary business. When, however, the Company found itself in difficulties the other point of view, that the waterway was largely a public utility undertaking, was accepted and the municipality came to its aid with sufficient finance to carry the work on. The City Council gave assistance to the extent of £3,000,000. Disaster came again. The Mersey and Irwell broke into the Irlam section and the Bollin also flooded two miles of cutting. By the summer of 1892 it was clear that a further £2,000,000 would be required. The special committee presented its recommendation to the City Council, which carried the report unanimously.

Manchester Corporation Participation

In recognition of its financial holding the Corporation was accorded an important representation upon the board of directors and consequently a share in the direction of the undertaking. This combination of municipal and private interests is unique in this country, although not unknown in the case of public utility concerns abroad.

The composition of the board is almost equally divided between the representatives of the shareholders and those of the Corporation: there being 10 directors elected by the shareholders and 11 appointed by the Corporation, constituting a directorship of 21, of which the chairman is elected by the shareholders' directors while the deputy chairmanship is held by a Corporation director. Corporation representatives are necessarily members of the City Council, and they automatically retire from the board of the Company at the end of their period on the Council, which for aldermen is six years and for councillors three years. On re-election to the Council the appointment to the Ship Canal Company's board must be renewed if the re-elected aldermen or councillor is to continue to be a director of the Company.

The influence of the Corporation upon the conduct of the Company's affairs is solely through its appointed representatives, who act upon their own judgment.

Spirits rose rapidly; following the Corporation's intervention faith in the enterprise revived and the railway companies soon began to make arrangements for access to the docks.

The cutting of the first sod set in motion one of the largest engineering works of its kind ever undertaken in this country. It fired public imagination and created the widest interest. Its

Manchester Ship Canal—*continued*

opponents for the most part still decried it and prophesied disaster of every possible kind.

Constructional Features

The route approved by Parliament lay along the line of the Irwell from the southern confines of Salford to the junction with the Mersey—a distance of $7\frac{1}{2}$ miles; it then followed the Mersey to Rixten, another 4 miles. Here, where the river makes a turn northwards the line of the Canal leaves it and is a virgin cutting, disregarding the course of the river for the next 23 miles to Runcorn, where it reaches the head of the estuary and continues along its southern fringe for a further 12 miles to the entrance at Eastham. This last section is for a considerable part of its length separated from the Mersey by embankments only. There is a narrow strip of foreshore for some distance west of Saltport; a spur projecting into the river at Stanlow, which was later to be used for oil docks, and a length west of that again upon which spoil was deposited to a considerable height forming a hill known to-day as Mount Manisty—after the engineer in charge of that section.

It was this last section to which I referred as being obligatory. There was much argument before Parliament as to the effect of the Canal on the Mersey channels. The fear was that anything which might interfere with the tidal flow would endanger navigability. Captain Eads, who had done notable work in forming a deep-water esturial channel in the Mississippi, was brought from the U.S.A. to give evidence for the opponents. In advancing the opinion that the channel designed to give access to the Canal might result in the silting up of the Liverpool docks he suggested that the danger could be overcome by continuing the Canal along the southern side of the estuary. The promoters promptly adopted the idea presented gratuitously by this extremely expensive witness for the other side.

Although I have said the course of the Canal for the greater part ignores the river it crossed it or impinged upon the river at many points and here the river course had to be deflected. There were, too, the tributary streams to be dealt with. The Bollin is accepted into the Canal near Warburton, as is the River Weaver west of Runcorn, but the Gowy, at Stanlow, is syphoned underneath the Canal.

The general excavated depth of the waterway is 28-ft.; it was originally 26-ft., the original depth of the Suez Canal, but powers were obtained in 1904 to raise the water 2-ft. In 1927 the lower $4\frac{1}{2}$ miles from Eastham to Stanlow were dredged to 30-ft. to enable ships of greater draft to use the oil docks and to afford additional water for laden ships bunkering at Stanlow on their way to sea. The width is generally 120-ft. at the excavated depth, but it is wider in places for convenience and narrower in a few places from necessity. The surface width varies with the character of the embankments; where it passes through rock the sides are virtually sheer. As I have already referred to the Suez, which so influenced the Manchester enterprise, I might say here that its original bottom width was 72-ft.—of course it has been much deepened and widened since its opening. A word about the levels and we may pass on from geographical to engineering considerations. The water level at Manchester terminal docks, $35\frac{1}{2}$ miles above Eastham, is 70-ft. above mean Mersey level and the Canal is maintained on five levels by five locking systems. The entrance locks at Eastham give access to the lower section of 21 miles which is semi-tidal. That is to say, the gates are open save when the Mersey level drops below the Canal level. The second lock system at Latchford raises the Canal $14\frac{1}{2}$-ft. for the next seven miles to the Irlam system which rises 16-ft. Barton Locks and Mode Wheel Locks (the entrance to Manchester Docks) account together for a further rise of 28-ft.

Each locking system consists of two locks: the larger 600-ft. by 65-ft. and the smaller 350-ft. by 45-ft. The larger lock at the Eastham entrance is an exception, being 80-ft. wide. The depth of water on the sill is also greater to meet the greater excavated depth of the Canal at the western end.

Each lock system has sluice gates to deal with surplus water and pumping equipment to enable upper levels to be maintained from lower levels to safeguard the waterway in times of drought. It will be appreciated that the locks are one of the governing factors in the size of vessel using the Canal. The depth of water and the height of the fixed bridges are also important. The clearance between normal water level and the underside of the bridges is 73-ft. 6-in.

The largest ships using the Canal are provided with telescopic masts and removable funnel tops which sheer legs, established at Eastham, remove and replace.

The water for the upper sections is supplied by the Irwell, the Mersey and the Bollin. The lower section is, as has been said, tidal, but it contains the River Weaver which joins the Canal west of Runcorn.

For six years after Lord Egerton cut the first sod on November 11th, 1887, steam navvies, mechanical excavators, grabs and dredgers and many thousands of men drilled, blasted and dug their way through the hard rock and boggy moss land. It was a stupendous task, but the great trench grew under Leader Williams' direction, controlled by the master hand of Thomas A Walker. Unforeseen difficulties sprang up like dragons' teeth all along its length.

Before the Canal was completed heavy rains caused floods and landslides which undid the labour of months; a stream disclosed itself under the piers of the new Irlam bridge and twice the tide swept through an embankment between the Mersey and Ellesmere Port. Added to these difficulties new problems were thrust upon the Canal Company by local authorities and railway companies whose roads and lines crossed the route. Soon after the contract for £7,750,000 had been signed, the contractor brought together enormous collection of excavating gear. During the busiest period of construction, there were employed about 16,000 men, 100 steam excavators of one kind and another, 194 cranes, 182 steam engines, 209 steam pumps, 59 pile engines and 196 horses.

The length of temporary railways amounted to 223 miles and the number of locomotives to 173. 10,000 tons of coal and 8,000 tons of cement were used each month. The total amount of excavation was roughly 51,000,000 cubic yards, or about 76,000,000 tons, one-fifth of which consisted of sandstone rock. 70,000,000 bricks were used; the masonry measured 220,000 cubic yards and the concrete 1,250,000 cubic yards.

Comfortable accommodation for so many men and their families near their work called for the erection of several villages of wooden houses and schools, churches, reading rooms and hospitals, with proper medical and nursing staffs were provided. Numbers of men engaged at the Eastham end of the Canal were housed at Birkenhead and Liverpool and were taken to their work each day by special steamer. When they reached the cuttings they were taken by train to their destinations. Everything was carefully organised, and in order that the men might loose no time in climbing in and out of the deep trenches ladders were provided which would take five or six abreast.

The route was divided into eight sections each with its own contractor's representative and engineer.

Not only did several main roads lie in the track of the Canal, which necessitated the building of swing bridges, but no fewer than five railway lines crossed the route as well. These included lines of the Great Western Railway, the Cheshire Lines and the London and North Western Railway, whose main line from London to Scotland was affected. Compensation to the tune of £533,000 was claimed by the railways from the Canal Company but they were awarded by the arbitrator just over £100,000. The routes of the lines were altered so that they should not cross and re-cross the Canal; two were carried over the Canal side by side at Acton Grange; and another at Irlam to take the Cheshire Lines Railway.

The building of the new railway tracks and bridges took four years, but the work was done while the bed of the Canal was being constructed.

Liverpool's fresh-water supply from Lake Vrynwy also had to pass under the Canal and this in itself caused some alarm and difficulty, because when the tunnel was almost finished a flood completely destroyed it and the work had to be begun again.

Later on, when an embankment a mile long was being built at Ellesmere Port the labour of hundreds of men, working at full pressure, was twice undone by high tides which swept up the Mersey and through a gap in the embankment.

Added to all these difficulties floods and gales and landslides in 1888 and twice in 1890 worked tremendous havoc along the works and added vastly to the expense of the undertaking. It has been estimated that these various calamities cost the Company between £2,000,000 and £3,000,000 and delayed the completion of the Canal by a year.

Besides carrying rivers under and railways and roads over the Canal it was necessary to find a convenient way of allowing the Bridgewater Canal to pass over the Ship Canal at Barton. Previously the Bridgewater Canal had crossed the River Irwell at this point by means of James Brindley's famous stone aqueduct. This remarkable example of early Canal engineering had to be completely demolished and it was replaced by a still more remarkable work of the present day—the Barton swing aqueduct by means of which that section of the Bridgewater Canal which crosses the Ship Canal can be swung aside on a central pivot to allow large vessels to pass. The aqueduct is 235-ft. long, 25-ft. wide and 33-ft. high. It contains 6-ft. of water. The swinging portion of the aqueduct weighs 1,450 tons; the weight it contains is 800 tons and the central pier revolves on 64 iron rollers. In addition to this aqueduct at Barton, seven other swing bridges carry roads cross the Canal.

Opening of the Canal

On November 25th, 1893, the finishing touches were made and water was admitted to the Canal from end to end. It was thrown open to traffic on January, 1st, 1894, when 71 vessels, gay with bunting and flags and crowded with cheering sightseers and distinguished civic representatives and Members of Parliament from all parts of the country, sailed up to Manchester

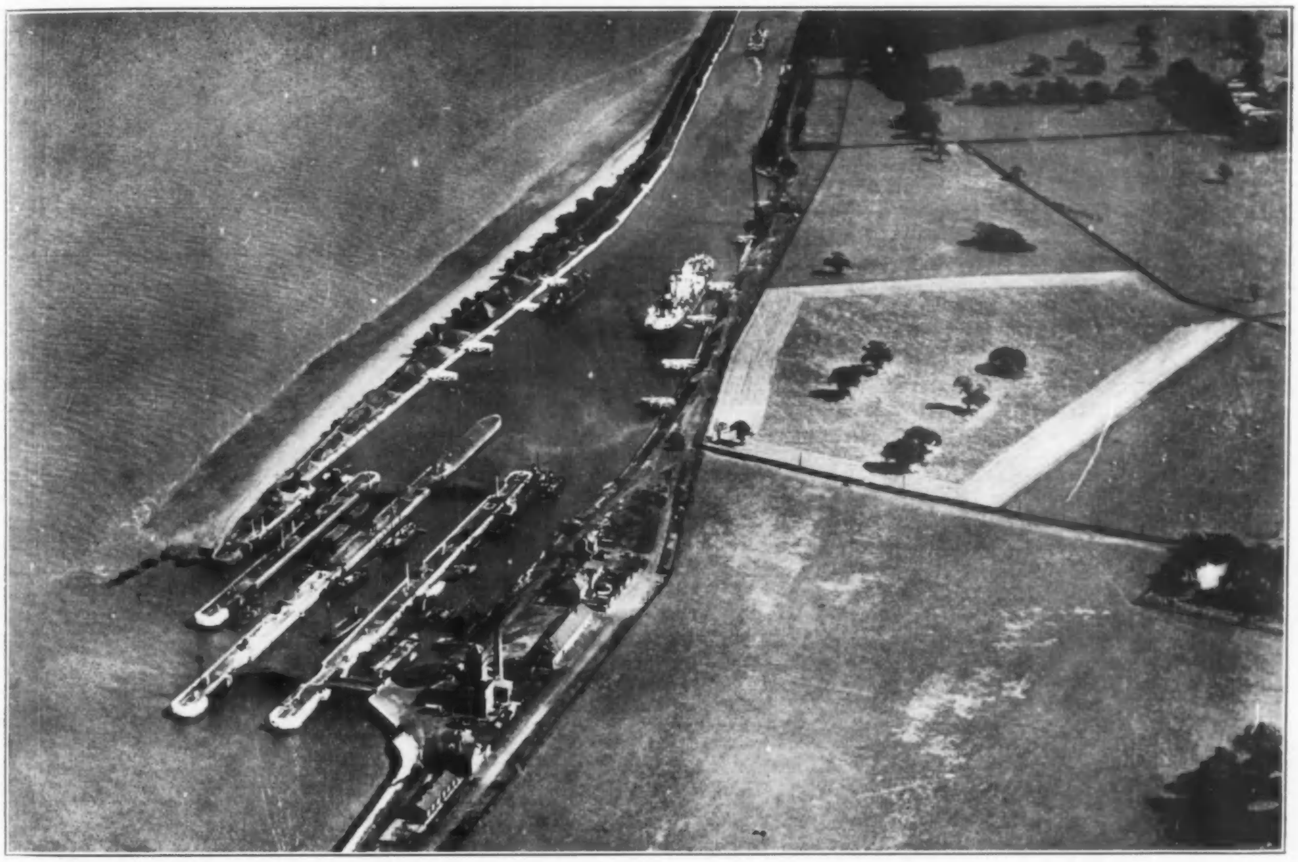
Manchester Ship Canal—continued

The Canal was officially opened on May 21st, 1894, by Queen Victoria, who, after inspecting the docks and pressing a button which operated lock gates at Mode Wheel, sailed along the waterway in the Admiralty yacht "Enchantress." At the time there was a good deal of disappointment that the engineer, Mr. E. Leader Williams, was not knighted at the opening ceremony, but the honour was conferred upon him in the following June.

The Port Undertaking

Having dealt with the physical characteristics of the Canal as an artificial waterway, let us now look briefly at the undertaking as a port.

I do not intend to describe the dock estate, docks, facilities and the like, which are beyond the scope of this lecture but it will be of interest to mention a few facts in connection with the service the Canal renders to Manchester. Perhaps the simplest way to do this would be to work our way along its route, beginning at Eastham and working eastwards to Manchester.



Eastham Locks on the River Mersey, six miles above Liverpool, the entrance to the Manchester Ship Canal.

The first point then for reference on this plan is Ellesmere Port, 3 miles above the entrance locks. The Ship Canal here encloses the terminal of the Shropshire Union Canal which is, of course, still operating to the Midlands. Considerable developments have been undertaken here, including new wharves and transit sheds and up-to-date coal conveyors. Industry is developing around this point and nearby a large paper mill recently established itself with a lay-bye for the discharge of wood pulp on the Canal.

Adjoining Ellesmere Port is Stanlow, where low flashpoint oils are handled. I referred earlier to the delta of land on the north side of the Canal at Stanlow. It was chosen on account of its isolated position as a site for oil docks. The first was opened in 1922 and the second in 1933. They lie at an angle to the Canal and their joint entrance forms a turning basin. As the tank farms of the oil companies are on the south bank the oil is pumped to them underneath the Canal. The most elaborate fire precautions are installed. To guard against the possibility of floating oil there are, in the Canal, above and below the docks, booms which can be floated across the waterway to enclose the danger area. The docks themselves have floating booms with which tankers are closed in during discharging operations. A boiler house in a remote position supplies steam to the ships' pumps. The oil tankage at Stanlow exceeds 88,000,000 gallons, that of the whole Canal exceeds 150,000,000 gallons, making Manchester the second most important oil port in the country—second only to London.

Weston Point and Runcorn, some 12 miles up, are the twin terminals of two inland canal systems; the Weaver Navigation and the Bridgewater. They both connect with the Midlands and the latter runs eastward to Manchester with a northern branch to Worsley, crossing the Ship Canal at Barton.

Weston and Runcorn are chiefly concerned with transhipment business for the Potteries—China clay, spar and so forth. The Canal, while passing a little south of the town of Warrington, carries traffic for that area, notably timber.

At Latchford Locks, near Warrington, we rise 14-ft. 6-in. from the semi-tidal section and near the head of this level stands Partington coaling basin. Nearby are the Irlam works of the Lancashire Steel Corporation, with its own lay-bye and waterside ore-handling plant.

At Barton we pass the Bridgewater aqueduct beyond which lie oil tanks for the less volatile oils and so to Mode Wheel Locks which maintain the uppermost water level at Manchester Docks.

We now reach the Port of Manchester itself. The Dock Estate at Manchester, excluding a development area of 1,000 acres adjoining Trafford Park, covers 406½ acres, including a water space of 120 acres. The quays total over 5½ miles in length. There are four docks for ocean-going vessels, ranging in size from 850-ft. long by 225-ft. wide to 2,700-ft. long by 250-ft. wide. Beyond these lie four smaller docks used for coasting vessels. They average something over 600-ft. in length by about 150-ft. in width.

The Canal and the Railways

As the opposition of the railway companies to the Ship Canal scheme has been referred to, it is interesting to see how the opening of the Canal actually affected the railways. The two companies by which the great bulk of Manchester traffic was then carried were the London and North Western and the Lancashire and Yorkshire. Their traffic receipts for the two years following the opening of the Canal are:—

	1895	1896	Increase Amount	Increase Rate p.c.
L. & N.W. ...	£11,519,292	£12,011,979	£492,687	4.27
L. & Y. ...	4,659,252	4,847,266	188,014	4.03
Totals ...	£16,178,544	£16,859,245	£680,701	4.20

Both railways set about increasing their terminal facilities. By 1911 the receipts of the L. & N.W. had riven to £16,448,693 and those of the L. & Y. to £6,728,273. To-day the Port of Manchester is one of the railways' best customers.

Before the Canal was built this strip of Lancashire and Cheshire, where it was not absolutely wild, was quiet farm land. Industrial development was envisaged by the promoters of the Canal who provided themselves with land for the purpose, and to-day the diversity of undertakings and the number of people they employ is remarkable. Between Eastham and the

Manchester Ship Canal—continued

Manchester Docks firms have established themselves dealing with chemicals, paper, iron and steel, oil, road dressing, salt, glass, timber, building stone, soap, leather, rubber, textiles, brewing, asbestos, machine and tool making, dyeing and bleaching and a hundred and one other commodities. In a word it is probably the busiest industrial zone of its size in the world.

Canal Shipping

The depth of water and the dimensions of the locks, as has been said, govern the size of vessel using the Canal. Ships of 15,000 tons d.w. capacity regularly navigate the waterway. Amongst the vessels regularly coming to Manchester are ships such as:—

	Tons Gross	Tons Net	Length	Beam	Depth
Northumberland ...	11,555	7,229	530	63	33
City of Paris... ...	10,902	6,855	474.7	59.3	32.6
Cornwall	10,603	6,637	495.1	63.1	40.3

During 1936 the tonnage of arrivals at the port was $4\frac{1}{4}$ million tons and during this period some 3,500 vessels entered the waterway.

The port's shipping services include regular services with the Canadian ports, Montreal, Quebec, St. John's and Halifax; U.S.A., North Atlantic, Southern and Pacific ports; South America, inward service only from the Plate; South and East Africa; India, inward from Calcutta and Colombo to and from Bombay and Karachi; the Persian Gulf; Egypt and the Near East; Australia and New Zealand; Tasmania; the Baltic and Scandinavian ports; Russia; Spain and Portugal; North Africa Africa and Morocco and the Mediterranean ports; Continental ports, French ports; Black Sea ports and coastwise services.

The revenue of the port is derived mainly from dues charged upon vessels using the waterway and tolls chargeable upon the freight they carry.

Dues are payable upon a vessel's net registered tonnage and tolls (corresponding to harbour dues at other ports) upon the weight of cargo. The Company is also the pilotage authority and provides towage services on the Canal.

The gross revenue for 1936 was £1,734,933, of which £357,210 represented the revenue from the working of the Company's railways, but to which may be added £184,225 revenue from the Company's Bridgewater Canals. The tonnage for the year 1936 was 6,373,308.

I think I might conclude this paper by calling your attention to the fact that although Manchester, a port by virtue of the Canal, the port of Liverpool with Birkenhead, and the ports of Garston and Bromboro' are under separate management, not only separate but an entirely different character of management, all these harbour works might be regarded as complementary to one another and forming one main western outlet, and, regarded as a whole, its importance may be judged from the fact that it handles approximately one-quarter of the whole trade of Great Britain and about one-third of the British export trade.

Port of New Westminster, British Columbia

Excerpts from Annual Report for 1936

The volume of traffic through and at the Port of New Westminster during the year 1936 recorded advances in keeping with the general economic improvement experienced during that year. The following is a summary of ocean-going traffic, with comparative figures for 1935:—

	No. of Vessels Arriving	Net Reg. Tonnage	Gross Tonnage
1936	525	1,857,784	3,035,139
1935	434	1,575,535	2,575,350
an increase of	91	282,249	459,789
or	21 p.c.	$17\frac{1}{2}$ p.c.	$17\frac{1}{2}$ p.c.

The volume of cargo tonnage discharged and loaded by vessels arriving and departing is as follows (in tons of 2,000 lbs.).

1936	1,008,019 tons	
1935	739,657 tons	
an increase of	268,362 tons	or 36 p.c.

To some extent the above-noted increase in traffic is due to the situation that existed at United States Pacific Ports during the latter part of the year, as a result of which certain tonnage was diverted to British Columbia Ports.

Fraser River Channel

Minimum depth of water on the ordinary high tide (12-ft. Sandheads) is 30-ft. or 21-ft. at low tide, from the entrance of the river to New Westminster, a distance of 22 miles. From New Westminster to Fraser Mills, a distance of three miles, the minimum depth at high tide is 28-ft. or 23-ft. at low tide. These controlling depths are determined by three comparatively short stretches of channel, namely, opposite Steveston (30-ft. at high tide, 21-ft. at low tide), Annieville Channel immediately below the City of New Westminster (dredged to 33-ft. at high tide, 28-ft. at low tide) and Port Mann Channel above the New Westminster Bridge (28-ft. at high tide, 23-ft. at low tide), there being ample depth of water elsewhere.

Additional works designed further to improve these shallower stretches are steadily being carried out by the Department of Public Works of Canada. During the year a very considerable amount of work was done in the vicinity of Steveston, including a further extension of 1,000-ft. to Woodward's Training Wall; the building of Albion Island Dyke N. 2, 3,018-ft. long, which it is proposed to extend this year another 4,482-ft. to a total length of 7,500-ft.; the purpose of these works being to confine the channel along this section and obliterate cross-flow during ebb tides. Extensive bank protection has also been carried out in this area, and more is proposed. The purpose of these works is to hold the existing channel and concentrate the action of the currents to the bed of the channel in the form of scouring rather than allow erosion of the banks and consequent shoaling.

Annieville Bar was dredged during the winter and the minimum depth increased from 23-ft. to 28-ft. at low tide. Dredging operations in front of the loading wharf of the Pacific Coast Terminals Company, Limited, are now being carried out and will be completed in May. This will give a depth of 30-ft. at low tide for a width at the entrance of 600-ft., width at lower end being 450-ft.

Bombay Port Trust

Excerpts from Administration Report, 1936-37

The Port of Bombay shared in the world-wide recovery from trade depression evidenced in the year 1936-37. The salient feature of this recovery was the universal and rapid improvement in world commodity prices, whereby the purchasing power of primary producers revived and was accompanied by an extensive rise in freight rates and recovery in shipping. India, in common with other primary producing countries in the world, advanced another step forward on the road to recovery. Improvement was particularly marked in the prices of agricultural commodities, and there was a definite tendency towards a better balance in the price relationship between agricultural commodities and manufactured goods.

The result of the year's working was a surplus of Rs. 14.74 lakhs on General Account, as compared with a surplus of Rs. 2.26 lakhs last year. This satisfactory result was achieved both by an increase in revenue and a substantial reduction in expenditure. The increase in earnings occurred mainly under Railway, Land Estates and the Bunders. The traffic on the railway was appreciably higher than last year, chiefly cotton, rice, seeds and manganese. Receipts from the docks, the principal revenue-earning department of the Trust, showed, however, no material variation as compared with last year or the year before. Although the earnings under docks wharfage on goods increased in consequence of larger exports of cotton, iron, manganese, groundnuts, oilcakes and seeds and imports of rice, this was offset by lower collections of ground and shed rents, due to reduction in the volume of imports and quicker clearances of goods.

In view of the better prospects of trade, the Trustees extended their usual policy of granting relief to trade by reductions of rates and charges wherever possible.

The cargo handled at the docks and bunders amounted to 5,460,000 tons, an increase of 142,000 tons, as compared with the volume of the previous year. Imports accounted for about 55 per cent. and exports 45 per cent. of the total tonnage. The increase in tonnage was equivalent to 2.6 per cent. Imports decreased by 5.12 per cent., while exports increased by 13.9 per cent.

Vessels which entered the docks or were berthed at the Harbour Walls (excluding ferry-steamers) totalled 1,954, with an aggregate tonnage of 4,998,513 net register, as against 1,950 vessels with a tonnage of 5,096,662 in the preceding year.

The dry docks were occupied during the year by 149 vessels, as against 170 vessels in 1935-36. The total tonnage was 543,739 tons, being 109,049 tons less than in the previous year.

To avoid any increase in capital charges, the Trustees curtailed their works programme by postponing all non-essential items. The total debt of the Board at the close of the year amounted to Rs. 19,09,97,783, of which Rs. 5,07,46,240 was due to Government and Rs. 14,02,51,543 was on account of Debenture Loans to the public.

The net expenditure on Capital Account during the year was Rs. 3,39,244, apportioned over various works.

The report is signed by Mr. G. E. Bennett, the Chairman.

War-time Port Operation

How to make the Ports more Effective in Time of War

By D. ROSS-JOHNSON, C.B.E., (formerly General Manager of the Port of Bristol)

THERE are two subjects which are now constantly before the public, viz., the establishment of inland depots for the storage of foodstuffs and other urgent needs of the people as a safeguard against the danger of air attack upon the ports where these are now chiefly maintained, and the very illusive probelm " Co-ordination of Transport."

It may not be immediately apparent what connection there is between these two questions or the bearing of either of them on the particular interests which are the main concern of this journal, but they are really very closely interrelated.

In designing any new system it is generally worth while to consider the history of the past, and it may be useful to recall some of the difficulties during the last war and the lessons to be learned from them.

Experience in the Past

At the outbreak of the Great War the inevitable conflict immediately arose between the needs of the expeditionary forces for the maintenance of their supplies and the needs of the civilian population for the maintenance of the necessities of life, so much of which had to be served by imports from across the ocean.

The railways worked very efficiently according to plans already made, which provided for their operation exactly as in peace time under their own organisations, the General Managers working as the Railway Executive Committee under the War Office. Southampton, a railway-owned port, was taken over entirely for war traffic, which enabled the expeditionary forces to be despatched with such smoothness. But as regards the other major ports, schemes had long before been prepared for the allocation of the various sections to various purposes. Owing to the want of co-operation among the numerous Government departments, however, these were almost at once discarded.

At these, on the day of mobilisation and afterwards, officers arrived representing every department of the State, armed, of course, with powers of D.O.R.A., Naval Transport, Army Embarkation, Army Service Corps, Ministries of Munitions and Food and various others, each having regard to no interests except those of his own department, and oblivious of the fact that a dock is after all only a large machine dependent for its working on the proper co-ordination of its several parts. The result was that the traffic passing through the ports was soon reduced to little more than half their normal capacity, and the Port and Transit Executive Committee, which was then established under the energetic chairmanship of Sir Norman Hill, spent the rest of the " duration " in restoring order. Doubtless these happenings have not been forgotten, and we may hope that the confidential War Book, which we are told is being constantly revised and brought up to date, will guard against such difficulties in any future emergency.

But there are certain features inherent in the problem which will always exist, viz., the best means of obtaining the rapid turn-round of the shipping, the orderly distribution of imports to their inland destinations and the transport of material to the ports for shipment.

In a time of national emergency, all sorts of abnormal conditions come about. Ships are diverted to unaccustomed ports, and arrivals become irregular. Under the convoy system they are brought in a large number at once, and then none for some time, instead of the accustomed more or less regular daily arrivals. And the rapid freeing of each ship, in order that it may be available for its next voyage, becomes of urgent importance. To do this properly, all sheds and quays must be kept clear and not commandeered for other purposes, as was so frequently the case during the last emergency.

But the number of berths in a port, even if kept available and fully utilised, does not mark the potential capacity of a port in busy times. Nearly always there is a sufficiently commodious basin to afford mooring space for a certain number of ships away from the quays. Ships so moored can discharge or load into barges on both sides. But, of course, the cargo in the barges has to be dealt with for transit inland and, except in the case of very mixed cargoes, which must be landed on the quay for sorting, much time and labour is saved when the barges can be sent away direct to destination.

So we reach the problem of inland transport to and from the ports, and it may be useful to recall again the conditions which prevailed throughout the duration of the last war. The internal movement of goods and passengers was far in excess of all records before or since. The internal traffic between one place and another was heavy, but this only indirectly affected the port traffic by getting in its way. But the ports became the dumping ground for all the army stores awaiting shipment, and for all the foodstuffs and essential goods imported. The munition factories, constantly adding to their number, were never provided with sufficient ground space or railway sidings to contain their output, much of which might not be immediately required for shipment, and they had perforce to turn it out as produced on to the railways. The railways, already congested, could not add to that congestion, and pushed it into the ports. These could not push it any further until the ship arrived, sometimes weeks later, to take it. So all the ports' sidings became congested, adding greatly to the delay in sorting out the particular trucks required for particular ships, which themselves generally arrived without notice, to enable preparations to be made for them. All this involved greater ship delays.

It was found impossible to obtain adequate storage inland for the foodstuffs which from causes already explained arrived in gluts, and so these could not be got away expeditiously out of the port areas. Most ports are equipped with granaries and warehouses sufficient to contain their normal imports, but, at frequent intervals during the war, these were very abnormal, and the difficulty of disposing of the cargoes involved further delays to shipping.

Thus the vicious circle was established: congestion on the roads and railways; blocking of the ports; delays to ships in process of discharge; consequent inability to deal with new arrivals; the reduced output from the ports involving reduced output from the available shipping; and delays in despatching army stores.

The provision of the inland depots will not, by themselves, solve the problem. They are bound up with the problem of transport. Fully stocked in advance, they will be a safeguard against the loss of supplies in the ports by aerial attack, and they will also be a safeguard against the falling off of normal supplies during the early stages of a war, with its inevitable dislocation of normal shipping services, but they will have to be continuously replenished during the duration of the war.

Waterway Transport Facilities

If the canals and inland waterways could be made available for this duty, and if the depots were suitably sited adjacent to them, as they very well could be and give access to every part of the country, it would leave the railways and roads free to deal with all the other needs which would fully occupy them.

The previous history of our canals and waterways was concisely, but quite adequately, dealt with in the Final Report (1931) of the Royal Commission on Transport. It describes the " Canal Era " from 1760 to 1830; the gradual decadence of the canals from the latter date with the rise of the railways, and the successive enquiries from the last-named date as to what should be done about them. Of these, the most important were Lord Shuttleworth's Royal Commission of 1906 and the Committee on Inland Waterways of 1921, under the chairmanship of the present Prime Minister. The coincidence of all their views is remarkable.

The most important waterways in the canal era provided communication between the four estuaries on which our principal ports are situated, viz., Thames, Severn, Mersey and Humber, and the Midland network of canals which has Birmingham as its centre. These four routes were described by the 1906 Commission as " The Cross."

The canals had suffered from the time of their construction from the absence of standardisation in the matters of width, depth of water and dimensions of locks, which made through journeys difficult, and, with the decline of their prosperity, they had further suffered from inadequate maintenance and, still more, from the fact that sections forming essential parts of through routes had been acquired by, or in many cases forced on to the railway companies, who naturally had not encouraged through traffic in competition with their own railways.

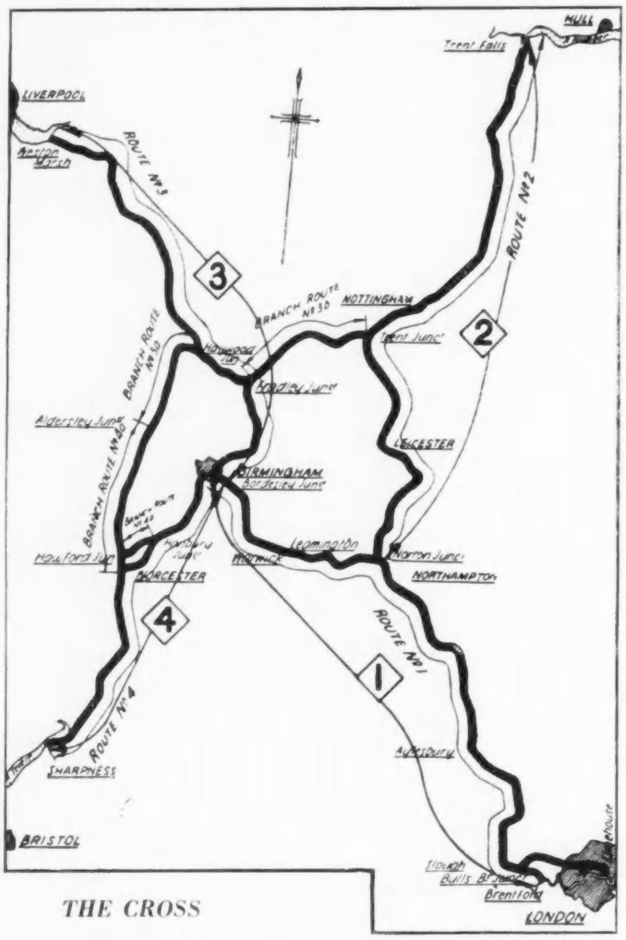
" Rationalisation " of Canals

So it was, and is still, essential that if the canals are to become a substantial part of the transport facilities of the

War-time Port Operation—continued

country they will have to be "rationalised," i.e., brought physically to a common standard of depth, size of locks, etc., and be put in a condition to use mechanical haulage, in lieu of the antiquated horse or donkeys, and to substitute, in some places, lifts or inclined planes for the long flights of locks which at present cause such serious delays.

In spite of all these drawbacks, the canal traffic has not been negligible. In 1905 they carried over 36 million tons, in 1934 nearly 12 millions, and in 1936 13½ millions, though, of course, these figures are not very impressive against the 280 millions of tons on the railways.



THE CROSS

An important question through all these successive enquiries has been up to what standard of capacity should the waterways be improved. There are two classes of craft used for inland water traffic, barges carrying from 100 to 250 tons, and monkey boats with a maximum capacity, when the depth of water is properly maintained, of some 35 tons. The former prevails on the greater part of the ways serving the four rivers named above, and the latter are used on the network of narrow canals in the Midlands. The chief disadvantage of the latter is that they cannot be used in the seaway of the estuaries, on which most of the ports are situated, and as the barges cannot, on the other hand, use the narrow canals, traffic for many destinations involves a transhipment.

After full consideration of all these conditions the successive reports have all concurred in the view that the canals have still very useful services to perform, and they advise:—

1. Unification of ownership.
2. Amalgamation of the existing companies into large groups to include the railway-owned canals.
3. Each group in the first place to contain one arm of The Cross.
4. Failing private enterprise, the groups to be owned and administered by Public Trusts, on which the various interests should be represented.

It may conveniently be stated here that some advance has been made already. Extensive improvements of the Trent Navigation connecting the Humber with Nottingham, Leicester, and the Midlands have been effected by the Corporation of Nottingham and the Trent Navigation Company, which will (in the view of the Royal Commission) give great advantage to the locality. The recently-reconstituted Grand Union Canal Company have acquired, and are in process of reorganising, the arm of The Cross from the Thames to the Midlands, as well as a part of that from the Humber. The recent Report of the Transport Advisory Council shows some small progress in the movement towards that co-ordination of traffic which would enable the waterways, if and when made efficient, to obtain those portions of the country's traffic which they can carry to the best advantage.

With the other arms of The Cross put into the same condition as that now being attained by the Grand Union Canal Company, and with the inland depots carefully located in relation to the canals, the imported food supplies of the country could be transported continuously from ship to depot by the cheapest method, free from all congestion on the railways and roads.

But nothing has been done yet to implement the recommendation of the Royal Commission on Transport of 1931 that

> "Failing the submission of voluntary schemes within a short period, the Minister of Transport should take steps to set up Public Trusts which would acquire such canals as he considers it would be in the national interest to preserve and improve. We are in agreement with previous investigators that the most important canals are those constituting 'The Cross': the four routes of the canals forming this system might first be amalgamated under four Public Trusts, with the ultimate fusion of the four into one large group."

Possibly, it has not been realised what an important element the canals should form in the schemes for the food supply of the country in time of war, and in the course of preparation for war.

It is not likely that private enterprise would be willing to take up the remaining arms of The Cross, as the Grand Union Canal have done for the first one, for the reason, as foreseen by the Royal Commission, that there is no one body on either with the outstanding interest to get out the necessary surveys and estimates.

Until this is done, the cost cannot be estimated. Lord Shuttleworth' Commission made an estimate of sixteen millions. But this, of course, cannot be much guide, as not only have prices altered, but their scheme was probably more ambitious than is really necessary. But the cost would certainly be small when compared with the sums now being spent on the roads and would come as a very small item in the bill for rearmament.

If some enterprising Member of Parliament would raise the question, he might render a service to his country.

Legal Notes

Unstable Channels in River Estuaries. Responsibilities and Duties of Harbour Authorities

(BY OUR LEGAL CORRESPONDENT)

On the 29th November last, in the Admiralty Division of the High Court, Mr. Justice Langton delivered his considered judgment in the action brought by the Owners of the ss. "Neptun" against the Humber Conservancy Board. The judgment contained comments on the legal duties of Harbour Authorities and included a list of their obligations in respect of the marking of navigable channels. This list had been drawn up by the Judge with the assistance of two Elder Brethren who sat with him. The case is therefore of particular interest to all those authorities who are concerned with beaconage and buoyage and the maintenance of a safe fairway.

The case arose out of the grounding and total loss of the steamship "Neptun," of Esbjerg, on the Whitton Sands in the River Humber in June, 1936. The owners of the vessel claimed damages against the Humber Conservancy Board on the grounds that the Board had failed to keep the Channel clear or to give notice of obstruction or to mark correctly the deep water channel. The Conservancy Board denied any obstruction or failure to mark the channel. They pleaded that the "Neptun" grounded on the river bed owing to there being insufficient water and that the light vessel had been moved that morning in conformity with the shifting of the channel and that notice had been published and could have been seen by the Master and Pilot before leaving Goole. The Board counterclaimed for £1,829, the cost of lighting and controlling the wreck. After a trial lasting seven days, the action was dismissed.

In the course of his judgment Mr. Justice Langton said that the navigation of the Upper Humber was never simple, and in parts was at times difficult and critical. The most critical part was half-a-mile between the Middle and Upper Whitton

Legal Notes—continued

Lightships, where the sand shifted rapidly and almost continuously, and the navigable channel was constantly changing so that the lightships had to be moved promptly. The pilot of the " Neptun " was aware before leaving Goole that changes had been observed in the channel and a lightship had been moved anew. The Board had advertised those moves with great precision.

The Plaintiffs' main point, continued his Lordship, was that the Board, as buoyage and beaconage authority, did not exercise reasonable care in the performance of their duty. His Lordship found that they did. It seemed necessary that the Court should define the functions of a buoyage and beaconage authority. Their common law duty was the same as that of invitor and invitee; they had a duty to exercise reasonable care, so long as they kept the highway open to those who used it, in order that those users might do so without danger to their lives and property.

Conservancy Obligations

Mr. Justice Langton said that he had asked the Elder Brethren, as experienced Shipmasters entering the Humber without knowledge of its channels, to help him in formulating a minimum list of the obligations of such an authority, and they said these were: (1) That the authority should have sounded and found the best navigable channel; (2) that they should have placed sea marks—lightships, floats and buoys—in the position where they would be of the best advantage to navigation; (3) that by night such sea marks should be provided with adequate lights, so as to enable the channel to be easily found and properly kept; (4) that the authority should have resounded the channel as and when opportunity presented itself; (5) that in view of the changes in the river bed they should keep a watch on the changes and should alter, move or renew the sea marks in accordance with the changes ascertained; (6) that records should have been preserved for future reference and the guidance of the subsequent officials; and (7) that the authority should publish, as conspicuously as possible, such further information as would supplement the guidance given by the sea marks.

With that short list of expectations for a great and busy highway like the Humber, his Lordship was of opinion that if one added that the Board should exercise reasonable care in the performance of those duties, the legal position of the Humber Conservancy Board was defined with sufficient accuracy for present purposes. The Board issued from time to time notices to mariners of special dangers which came to their knowledge, or changes in sailing marks, and charts were issued on which was defined a line of channel. .

For the pilot, said his Lordship, it was said that he was entitled on the indications of the charts to expect a minimum of 3-ft. of water at low water ordinary springs. It was not part of the case of the Conservancy Board that the pilot acted with negligence in proceeding as he did. There was produced the record of the tide board and a list of 27 ships navigated by the pilot in the preceding month, and the " Neptun " was the only ship which enjoyed the unenviable distinction of an accident.

Mr. Justice Langton pointed out that while the Plaintiffs put their case on a variety of grounds—contract, breach of duty or warranty, and negligence—their Counsel concentrated on the best, that it was the duty of the buoyage and beaconage authority to exercise reasonable care in the performance of their obligations to users of the highway. At the same time Counsel did not shrink from the absurd proposition that the Board had been discharging their functions for 30 years without discovering what were their obligations. It was impossible to find a reported case in which the practical obligations or legal duties of a buoyage and beaconage authority had been laid down.

The Judge said that the clearest statement of the relevant law was by Lord Wright, in the King's Bench Division, in the St. Just Steamship Company, Ltd., v. Hartlepool Port and Harbour Commissioners. Lord Wright said the liability of the Commissioners did not depend on the terms of their private Act of Parliament but on special relations arising *de novo* as each ship entered the port, analogous to the duty existing between invitor and invitee. It seemed to Mr. Justice Langton that the Humber Conservancy Board, as the beaconage authority, entered into just such a special relation as Lord Wright described. It could not be stated exactly as a relation of invitor and invitee, since it was difficult to imagine an invitation to use a common highway, but on the common law their position was the same.

It was proved, said Mr. Justice Langton, that while the Board exhibited plans indicating a minimum depth of 3-ft., from time to time they issued notices saying that only one or two feet were available It could not be said, as the Plaintiffs' Counsel wished, that there was a representation that there was at all times a minimum depth of not less than 3-ft. As he heard Counsel's criticisms, he began to wonder whether any buoyage or beaconage authority could hope to stand up to such an exacting standard.

His Lordship found that the officials responsible for the position of the light vessels could not have acted better than they did, bearing in mind the imperative demand for dispatch. As to a warranty of a minimum 3-ft., there was no such warranty. The documents and evidence showed that for forty years the defendants had striven with success to provide a channel with a minimum of 3-ft. The chart was merely a representation of the soundings found in the channel on the day on which it was exhibited. It was within common knowledge that the channels changed with bewildering rapidity. He was quite unable to see how the notices, alone or with the charts, could be taken to be a representation that a minimum of 3-ft. existed in the channels, which were quite undefined in their lateral extent.

The Judge referred to the calling of an expert hydrographer, Mr. Gibson, as a witness for the Plaintiffs, and said he thought that the Conservancy's engineer, Mr. Butterfield, and Mr. Booth, who made the soundings, met Mr. Gibson's challenges with spirit and composure. The Judge spoke highly of both these gentlemen and pointed out that they had a lifelong experience of the Humber, of which admittedly Mr. Gibson knew nothing.

Pilot's Misjudgment

In view of the fact that the case might go higher, his Lordship said the pilot was a man of cautious character, who made his choice on information at Blacktoft, but unfortunately his calculations were based on too small a margin of safety, and they were upset by a cause utterly beyond his control. His Lordship would say the accident was a combination of poor judgment and misfortune. The pilot passed closer to the Middle Whitton Lightship than vessels were accustomed to pass that mark, and the vessel which accompanied him, with the same draught aft and less forward, was able to wrench herself free from the sandbank, whereas the " Neptun " with the same draught overall, stuck fast. The " Neptun " would not rise the 2-in. expected on meeting the brackish water, as she was going at full speed. The Elder Brethren took the same views and the action must be dismissed, with costs. Counsel could agree as to a form of declaration upon the counterclaim and bring it to the Judge on some other day to sign in his private room.

Analagous Cases

It will be seen that this judgment was based on a well-established and apparently simple rule of law. The obligation of Harbour Authorities to take reasonable care in carrying out their duties was clearly laid down by the House of Lords many years ago in the case of Gibbs and the Mersey Docks and Harbour Board, and it has been followed in many cases since, including that of the St. Just Steamship Co. against the Hartlepool Port and Harbour Commissioners in 1929, referred to by Mr. Justice Langton (report in Vol. 34 of Lloyds List Law Reports, page 341). It is interesting to note that Mr. Justice Langton, then Mr. G. P. Langton, K.C., appeared in that case as leading Counsel for the successful Steamship Company.

Readers may recall that in the Hartlepool case, the ss. " Orient City " fouled the submerged wreck of the " Burnhope " which had foundered in the fairway with a full cargo of coal twelve years previously. A year or so after the sinking of the " Burnhope," the then Harbour Master of Hartlepool had carried out some grappling and sweeping operations at the spot but with a negative result. It was apparently assumed that the wreck had dispersed. Immediately after the accident to the " Orient City," however, the newly-appointed Harbour Master commenced sweeping and within two days discovered the wreck of the " Burnhope " and her cargo. In the view of Mr. Justice Wright (as he then was) the failure to locate the wreck and remove it was, in the circumstances, a failure to exercise reasonable care.

The legal rule also came under discussion in the recent Scottish case of the Owners of the ss. " Moray Firth " against the Aberdour Harbour Trustees, commented on in the August, 1937, issue of this Journal. That was another case in which the decision was against the Harbour Authority. The Harbour Trustees had failed to keep the harbour free from obstruction owing to lack of funds. That may not have been unreasonable, but they also failed to notify shipping of the fact or to issue a warning that in consequence the harbour might be dangerous. That was a failure to take reasonable care.

It might seem somewhat surprising that so much litigation should arise when the law is so clearly and firmly established, but the circumstances of no two cases are exactly similar and, hitherto, there has been no legal definition of what constitutes the " reasonable care " which the law requires. It is in this respect that the case under review is of importance. It has resulted in the laying down of a set of rules the observance of which was regarded by the Judge and Trinity Masters as the minimum required to fulfil the duty of taking reasonable care.

Uniform System of Buoyage

Address to the Eighth Interstate Conference of Australian Harbour Authorities, by Mr. A. D. Mackenzie. M.Inst.C.E. Engineer-in-Charge, Ports and Harbours, Victoria

At the opening of the Conference, the Chairman expressed a wish that delegates should be as brief as possible. I hope to be as brief as I possibly can, but I regard this subject as one of the more important ones on the agenda paper, and I would like to place it in some detail before the Conference. Before moving a motion on the subject, I desire to say that I was particularly pleased to hear the general remarks of the Hon. the Minister for Works and Local Government, Mr. Spooner, and also the remarks of the Right Hon. the Lord Mayor, Hon. A. Howie, M.L.C., who each stressed the desirability of uniform practices amongst the various ports of the Commonwealth. It has been equally pleasing to hear so many delegates express themselves generally in favour of uniformity on port practices. I hope that there will be no somersaults, and that those delegates will still have those views when this motion is put to the vote. I move:

"That this Conference adopts as a basis for a uniform system of buoyage the proposals set out in the draft agreement and rules prepared by the small committee of experts in London in February, 1936, and now embodied in the League of Nations' documents C 128 (A) M 67 (A) 1936 viii, and that each port authority of the Commonwealth proceed to put into effect the proposals as soon as the agreement has been ratified by the minimum specified number of ten signatories."

At the Fourth Conference, in Melbourne in 1924, the delegates were of opinion that it was desirable to give consideration to a universal system of buoyage as proposed by the International Hydrographic Bureau. The subject was again discussed at the Fifth Conference, at Adelaide in 1926, when the resolution carried was of a more definite character. That Conference decided in favour of uniformity in buoyage and buoy lighting, and recommended that the proposals of the International Hydrographic Bureau be adopted wherever practicable, and as opportunity offered. Nothing, however, eventuated, and the subject lapsed. The paper that I have prepared reads:—

In this Commonwealth, as in all other maritime countries, one would expect to find a matter of such vital interest to the community dealt with on systematic lines and methods brought to a high state of perfection. One would expect that the Harbour Engineer could refer to his standard engineering text book to guide him when laying down new beacons, buoys, lights, etc. At present he can follow any one of several practices or go off at a tangent, and devise a new one of his own.

Uniformity of treatment would appear to the most obvious of desiderata, yet instead we have a diversity of practices which can only at times serve to confuse rather than assist the navigator. Probably the first instance of a distinctive aid was provided at the entrance to the harbour of Alexandria in the form of a beacon, which was known as the Pharos Lighthouse or Tower, and was constructed about 270 B.C. A powerful beacon light burned at the top of the beacon, and has been stated by various writers to have been visible for thirty-four miles.

There have been instances of conservatism in regard to progressive moves intended to assist the navigator, and it may be interesting to quote from a letter from the Mayor and Corporation of Liverpool, in writing to their representative in Parliament in January, 1670, as follows:—

> "In regard to those lighthouses they will be no benefit to our mariners, but a hurt, and expose them to more danger if trust be had to them; and also be a very great and unnecessary burden and charge to them."

This is recorded in "Transactions of the Historic Society of Lancashire and Cheshire."

Through the ages since, beacons, etc., or let us refer to them as aids to mariners, have been constructed by various authorities, just as they are to-day, and without any completely systematised principles to guide them. In Great Britain, authorities existed in Trinity House, the Commissioners of Northern Lighthouses, Commissioners of Irish Lights and numerous port authorities. Divergent practices naturally resulted there.

Conferences were held at which interested parties attended, and some success at uniformity of practices was achieved in 1883, the system evolved then being substantially in force today in so far as the British Isles is concerned. In 1889, a similar effort was made, this time international in character, at a congress held in Washington. Some consolidation of practices was again achieved. It should be noted here, however, that light buoys were practically unknown. Certainly the flashing light was not in existence, and this has an important bearing on the present-day desire to unify or systematise buoyage practices. At a later international Maritime Conference held in St. Petersburg in 1912, at which, however, the United Kingdom was not represented, light buoys were again not considered. Light buoys have now, however, become such an integral part of any buoyage system, and the tendency to-day is to convert all buoys into light buoys, since it is illogical to define a channel or indicate a menace by day and not do so by night, or, in other words, it is unreasonable to lay down rules regarding characters of buoys or marks by day without reference to the night characters.

Continuing, we get to the League of Nations and its efforts to bring the matter of this all-important buoyage up to date and in keeping with modern requirements. 1883 and 1889 is a long time ago, the days of sailing ships, slow speeds, when ships hove-to till daybreak before entering port, and there was ample time to check position and observe shapes, colours, relative positions of one aid to another—very different to the present day with speeds up to 30 knots, quick decisions being necessary on the part of the navigator. There must be absolutely singular and distinctive characteristics to the aids provided for his guidance, particularly with relation to night navigation, now that most ports have a background of shore electric lights of such variety of colour and animation.

A conference was held at Lisbon in 1930 when opinions were divided, and no unanimity of thought or action appeared possible. The matter has been persevered with, and we find a small committee of experts set up, following a resolution by the Advisory and Technical Committee for Communications and Transit of the League of Nations, the committee being selected from among the members of the Prepartaory Committee on Unification of Buoyage Rules, which met in London in 1933. The small committee met in London in 1936, and its report and recommendations are the proposals which have been submitted through the Commonwealth Government as the basis of an agreement for signature and adoption by nations favourable to accept them as being suitable for a uniform system of buoyage.

In passing, it is considered worth while to comment on the personnel of this committee, since at a recent meeting of the permanent Committee held in Melbourne, a query was put as to whether competent authorities had drawn up the proposals. The committee which drafted the proposals was thoroughly representative of the maritime, engineering and nautical and naval professions of Europe, and consisted of an Elder Brother of Trinity House, a Spanish lighthouse engineer, a French lighthouse and buoyage engineer, an Italian naval commander, a Dutch lighthouse engineer, a Swedish Director-General of Pilotage Lighthouses and Buoys, with Sir John Baldwin as Chairman of the Committee. It can be accepted, therefore, it is felt, that the committee was equal to the task before it.

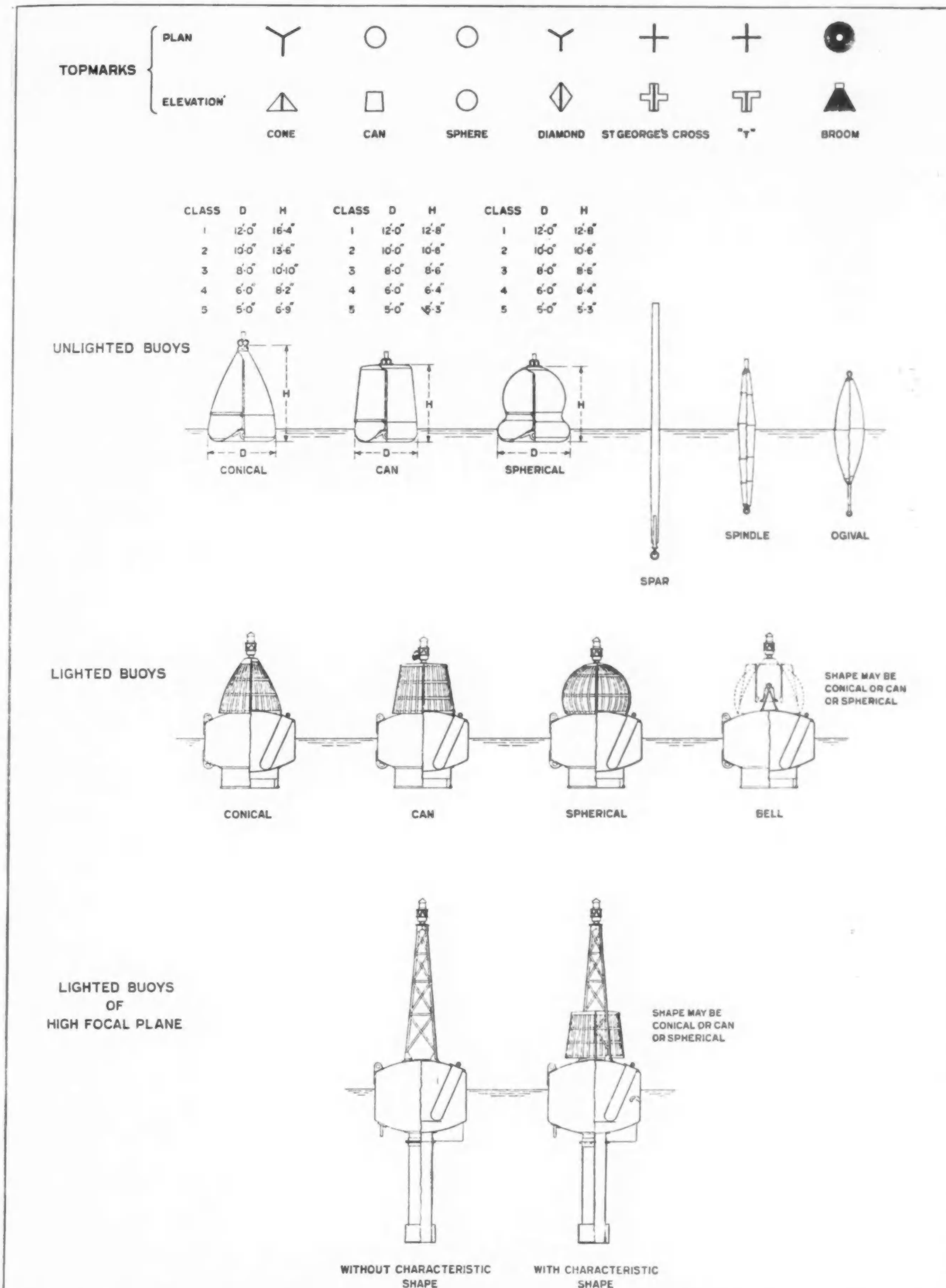
I would like to quote from a paper prepared by Monsieur C. Ribiere, Doctor of Science, when engineer in chief of the French Central Lighthouse Service. The quotation is as follows:—

> "Some of the most maritime disasters have been caused by the imperfect knowledge mariners have had of how to recognise a light by its character. In order to minimise this danger, we are forced to simplify and systematise the distinctive characters so that it is easy to learn and remember them. A recent instance is the loss of the 'Winton' in South Africa."

It is some years since this engineer made the above comment, and as already stated, with the greater speed of modern vessels, coupled with the fact of the confusion to an oncoming vessel, due to a background of multi-coloured and bright lights, quick recognition of a mark or light is essential, and calls for simple systematised characteristics.

The advance and progress of civilisation demands practices in keeping with such progress, one of the demands being for the use of as much of the twenty-four hours of each day as possible, and this necessitates a buoyage system which will bring these high-speed vessels into port safely on schedule day or night, and it will not be disputed that night navigation is, if anything, the more dangerous, and this primarily has brought about the present demand for a revision of practices. The Australian Shipowners' Federation has stated an objection to conversion to the proposals on account of cost, but it is felt that there may be some misconception on the matter, and that the costs, on analysis of the proposals, may not be as high as anticipated. It is difficult to appreciate why the shipowners have adopted this attitude, since the loss of one single vessel, due to lack of proper guidance or direction by a buoyage system, would outweigh many times the cost of conversion to the proposals. With more direct reference, however, it should be remembered that the navigator is the technical custodian of the shipowners' property, and complaints have been received on several occasions from navigators relating to the confusion that they experience as a result of interference of shore lights with buoyage lights, and this, it is claimed, is a definite reason for a revision of practices, and, possibly, in

Uniform System of Buoyage



CLASS	D	H	CLASS	D	H	CLASS	D	H
1	12'-0"	16'-4"	1	12'-0"	12'-8"	1	12'-0"	12'-8"
2	10'-0"	13'-6"	2	10'-0"	10'-6"	2	10'-0"	10'-6"
3	8'-0"	10'-10"	3	8'-0"	8'-6"	3	8'-0"	8'-6"
4	6'-0"	8'-2"	4	6'-0"	6'-4"	4	6'-0"	6'-4"
5	5'-0"	6'-9"	5	5'-0"	5'-3"	5	5'-0"	5'-3"

Notes on the Diagrams illustrating buoyage marks defined in the draft rules:—

Starboard-hand Marks. Shape, or type: conical or spar. Colour: black, or, for purposes of differentiation, in the case of conical marks, black and white chequers; in the case of spars, for purposes of differentiation or visibility, black, with the upper part white. Top mark (if any): Cone, point upwards, coloured black, or, for purposes of differentiation, a diamond, except at the entrance of a channel.

Port-hand Marks. Shape, or type: Can or spar. Colour: Red, or in the case of can-shaped marks, for purposes of differentiation, red and white chequers. Top mark (if any): Can, coloured red, or, for purposes of differentiation, a "T." except at the entrance of a channel.

Lighted Marks. On starboard-hand, white lights, showing one or three flashes or occultations, or green lights of a character not allocated to the marking of wrecks. On the port-hand, red lights, showing any number of flashes or occultations up to four, or white lights showing two or four flashes, or occutations.

The foregoing notes are not complete—for further and more precise information, reference should be made to the Rules.—(H.M. Stationery Office, 1s. 3d. net).

Uniform System of Buoyage—continued

addition, the exercising more control over the exhibition of certain classes of coloured and animated lights which are used on shore for advertising purposes. Captain Davis, Commonwealth Director of Navigation, will support me in this matter, since recently he had occasion to discuss this aspect with me regarding a light which it was proposed to exhibit from the top of a prominent building in Geelong, when he felt, having the interests of navigators foremost in his mind, that this light, if proceeded with, was likely to be a potential menace and cause confusion with navigation lights. In this particular instance, I held the opposite view, but whatever the merits or otherwise of the particular case, it goes to show the need for some regard being had to the fact that progress demands these lights ashore. Whether they can be stopped entirely or not is another matter, but there is every reason to feel that aids placed in channels should be so distinctive and singular in their appearance and characteristics as to lessen the risk of confusion with shore lights.

Pilots and exempt masters have stated that the are subject to confusion. Objectors to uniformity will probably say that because we have pilots and exempt masters, then there is no need for uniform practices to be followed. So far as the shipowners are concerned, I have no doubt that, if a ship is lost as a result of this confusion or lack of distinctiveness, they will demand safeguards for the future, and, if it is not this year or the next year, there is little doubt that ultimately demand will be forthcoming. The Board of Trade, which, as the shipowner knows very well, is concerned with the safety of ships and the men who man them, has stated that the proposals before us now embody the best arrangements for a uniform system of buoyage.

It can safely be said that there is no completely uniform system of buoyage in existence in the world to-day, although, so far as daylight practices are concerned, America claims that the system evolved at Washington represents 75 per cent. of the buoyage of the world, but the bulk of this system is in existence in American waters, with its extensive length of inland waterways. Elsewhere, a variety of practices is followed. The Washington system is uniform, so far as such daylight fundamentals as colour, shape and numbering are concerned. That system with daylight colour demarkation is red to starboard, and black to port, and it is only in regard to colour that we might say there are two uniform systems in vogue, the one the opposite to the other. The advent of radio beacons is indicative of further progress, and, as with lights, so must provision be made for distinctive individuality and uniformity. Naval and air bombing and air gunnery practice areas must be singularly defined. The task, therefore, before the Expert Committee in London, was apparent, and with a full knowledge of world practices before it, the proposals we now have were evolved. A commanding point is the fact that, notwithstanding that such a percentage of existent buoyage was contrary to its recommendations, the committee met the problem scientifically and has given a scientific solution to each peculiar circumstance, and so well received and acceptable are the recommendations that the following nations have expressed themselves as either wholly or with some reservations in favour of the proposals as a basis of uniformity. It should be noted that many of these nations which have expressed themselves as favourable now conform in some way or other in general fundamentals to the 1889 Washington scheme, but yet they are prepared to convert and benefit by the advantages to be obtained by conforming to the proposals, those nations being not only adjacent to Great Britain and Baltic countries, but comprising all Mediterranean countries, and even as far distant as China. Those nations declaring in favour are: Germany, Portugal, China, Denmark, Bulgaria, Danzig, Egypt, Spain, Finland, Esthonia, Irish Free State, Iceland, Italy, Latvia, Lithuana, Norway, Netherlands, Poland, Roumania, Sweden, Soviet Republic, Yugo Slavia, whilst those which have definitely declared against the proposals are: Canada, United States of America, Japan and Chili. The objections of the United States of America are probably typical of the other objectors, and are based primarily on the fact that their practices are the exact opposite to the proposals, and that the cost of the change in demarkation, charting and publications would be too great.

It should be noted that the objections to uniformity are not offered because pilots and exempt masters use their ports, because the objecting nations are favourable to a uniform system providing that system is based fundamentally on the system which they now follow.

When one analyses the position in relation to those nations which have declared themselves as being favourable to the League of Nations' proposals, and the vessels which belong to those nations, and use the ports of this Commonwealth, the position becomes one of interest and significance. Taking figures relating to shipping movements at the Port of Melbourne in 1936 as a basis, and such data might be accepted for purposes of comparison so far as other Australian ports are concerned, it is revealed that in 1936 visitations of vessels belonging to nations which have declared themselves favourable to the proposals are as follows:—

Britain	687
Norway	77
Holland	41
Germany	57
Sweden	27
Italy	16
France	1
Denmark	7
Others	11
Total	924

whilst visitations from vessels belonging to nations which have declared against the proposals are:—

Japan	82
America	43
Total	125

In addition to these visitations, there were 2,481 visits to the port by inter- and intrastate vessels.

It will thus be seen that, if Australia declares in favour of the proposals, our ports (using the Melbourne figures as a basis) would be patronised by vessels which would be concerned only with the League of Nations' proposals, that is, to the extent of 3,405 visitations, as against 125 visitations of vessels of nations which are against the adoption of the proposals.

The Chinese reply to the proposals is concise, and summarises the position very well, in my opinion, and is quoted hereunder:—

> "Generally it appears to us from a perusal of the observations of the various Governments that there is a fair prospect of quite a wide regional agreement being arrived at if a reasonable spirit of compromise be exercised. The United States of America, Canada and Japan must, of course, be excused, owing to fundamental differences in their proposals and practices. The communication submitted by the United States of America in support of their position appears to consist merely of a re-statement of the arguments they put forward at Lisbon, which were then fully discussed and to a large extent rejected as unsound. We concur in considering the United States of America arguments unsound in a number of important aspects. The Preparatory Committee's scheme now under consideration must, in our opinion, be recognised to be a compromise scheme, falling short of the ideal in many important respects, but nevertheless constituting a valuable advance towards the future ideal scheme of uniformity. It is because China considers the scheme to represent a step forward towards the future ideal that she is prepared to support it. Actually, her delegates on the Preparatory Committee endeavoured to obtain what they consider would have constituted a valuable further advancement towards the ideal scheme, such as distinction of the side lights in the lateral system of buoyage by colour, but without success, and it appears plain that under the present conditions obtaining in the different countries, advancement towards the ideal can only be made gradually, and by exercising the utmost spirit of reasonable compromise."

It should be remembered that there are pilots in Great Britain and other maritime countries just as there are in the Commonwealth. Yet in the light of this, the nations mentioned as being in favour of the proposals are prepared to convert and systematise their practices for the benefit of those pilots and exempt masters as well as others. It might be as well to mention at this stage that the maritime nations of the world have previously agreed to systematise practices, and no great objection was met with when the steering orders were diametrically changed from a system that had been in use for years, and again with the international code flag system.

The Expert Committee in London then had to devise a system of demarcation after it had analysed the replies from all nations which had been communicated with, including the lengthy, detailed negative reply of the United States of America to the original proposals of the Preparatory Committee. The requirements of such system called for conspicuousness by which the marks or signals could be seen for a considerable distance, individuality by which they could be selected from other marks or signs, simplicity and unalterability of character.

The accepted method of characterising marks is by shape, colour and lettering by day, and by night by colour and rhythm. The fundamental by day, however, is shape, colour being regarded as supplementary, and also numbering. It is permissible under the proposals to characterise shape by either the shape of the upper part of the body of the buoy or mark,

Uniform System of Buoyage—continued

or by the substitution of a top mark shape—this being most important, so that the objectors to the proposal, who say that it is necessary for them to convert costly buoy shapes to conform to the proposals, need have no apprehension in this regard, since the cost of a top mark is relatively low. It will be generally agreed that the cost of painting a black buoy red, or vice versa, will not be expensive, likewise the question of re-lettering or numbering the marks, the principal cost being in the alteration to charts and publications.

The Committee has had due regard, it is obvious, to present practices, and the use that may be made of them where possible, since they accept the fact that the conical-shaped buoy is generally used to starboard and the can-shaped buoy to port, and retain this principle in their recommendation, since there can be no point gained in placing a conical-shaped buoy on the one hand or the other, no scientific principle being at stake.

The most difficult period of navigation is during the night or dark hours, and the Committee approached the subject on the assumption that safe inward navigation was the foremost consideration. In other words, consideration should be given the requirements of the incoming vessel over the outgoing one, on the basis that the ship proceeding seawards was leaving a port sure of its position and in full possession of the whole of the facts relating to its outward passage proceeding from buoy to buoy and light to light from a shore commencement. On the other hand, the incoming vessel very often has to feel its way, sometimes with anxiety, looking for its first sight of the port's buoyage system. This principle established to the Committee the fact that the starboard hand light or mark was the one demanding first consideration, and, taking night conditions, there were four colours available for the general purpose of demarcation—white, red, green and blue, the latter colour, however, being rarely used, due to it absorbing such a large portion of the luminous rays so as to practically preclude its use. The relative merits of the other colours are in terms of visibility in miles under equal conditions, being somewhat as under:—

White	10 miles
Red	7 miles
Green	4 miles

and for this reason a white light was determined upon for starboard hand light, and this must consequently reduce the risk of collision at entrances or approaches to channels, especially during bad conditions of visibility, since a white light is seen furthest away, and the vessel immediately shapes its course accordingly to its right side of the channel. It follows, then, that the next best colour, red, is chosen for the port side, whilst it is the desire of the Committee to reserve green as far as possible for wreck marking or other distinguishing purposes. It is preferable also for red to be on the same side as the incoming vessel's own red light, and in accord with the seaman's ritual of Red to Red—Perfect Safety—Go Ahead. The logical colour by day for port hand marks is red, to correspond to the night demarcation, and again since black is the best colour to be seen by day, this accords with the principle previously indicated, of bringing an incoming vessel to its right or starboard hand position in the channel as soon as possible, and black is accordingly the starboard hand daytime colour.

The numbering of the marks is a minor matter, and, since the outer starboard hand mark is the first one that concerns an incoming vessel, so it becomes number (1)—odd numbers follow the markings on the starboard hand, and even on the port hand. Likewise, starboard hand white lights in regard to rhythm have odd numbers of flashings or occulations, and green lights under certain circumstances, and port hand red lights have any number of flashings or occulations up to four, or, if white be used for distinguishing purposes, even groups of two or four.

Article (1) of the agreement allows of a transition period of ten years. Article (2) states that departures from the rules are permitted, having regard to local conditions or exceptional circumstances, and, more particularly, where adoption of the rules in question might endanger navigation, or where the expenditure involved would be out of proportion to the nature and extent of the traffic.

It should be understood that the rules proposed for adoption would not have the effect of compelling any State to employ all the modes of marking referred to therein or even any they do not at present employ. The rules simply indicate the characteristics that should be adopted if those marks which are already used or may be used in future on the coasts of any particular country are required in order to meet fresh needs which may arise, quite apart from the rules themselves.

Concluding its report, the committee stated, *inter alia*, "The wording of the two documents, as will be clear, if they are carefully studied, has been made as elastic as possible as regards both individual articles in the rules and Article 2 of the Agreement."

The object has been not only to pay due regard to various special situations which exist or which may arise in the future, but also to facilitate the achievement of adequate uniformity wherever such is desirable and possible. If one authority had control of all ports, there is no doubt that uniformity would, in my opinion, be achieved overnight.

I conclude by saying that I hope it will not be through lack of understanding that my motion will be rejected, if it is rejected. I trust that the motion will be carried, because I feel that if the proposals are turned down now we may not get another opportunity to come into line with the progress which I have indicated, and things will be made more difficult for us in the future. So far as Victoria is concerned, we have three or four hundred aids, and I think I mentioned the sum of £300 or £400 as the amount necessary to carry out these proposals. Mr. Macindoe has informed me that in New Zealand they have a uniform system. The various port authorities there have recognised the desirability and the necessity for a uniform system. New Zealand does not at present conform to the proposals I have set out because they were not before the New Zealand Harbour Authorities in 1926, when they adopted a uniform system. I am beginning to appreciate, after hearing Mr. Macindoe, that New Zealand is a progressive country, and that, so far as harbour matters are concerned, it is, in many respects, ahead of Australia. New Zealand is setting the pace, and we should endeavour to catch up with it. I do not say that New Zealand will immediately alter its existing system to conform with these proposals, but if Australia adopts them, New Zealand may be prepared to follow her example.

Estuary Channels and Embankments

The Vernon-Harcourt Lecture was delivered at the Institution of Civil Engineers, by Dr. Brysson Cunningham, M.Inst.C.E., on 8th December, 1937.*

The chair was taken by Mr. F. E. Wentworth-Sheilds, O.B.E., M.Inst.C.E., Member of the Council of the Institution.

After pointing out the difficulty of formulating a satisfactorily comprehensive definition of an Estuary by reason of the great difference in the physical characteristics of estuaries, and in the variability of the extent of rivers to which the term is appropriate, together with the importance of tidal action as affecting navigation, the lecturer proceeded to discuss the two chief objects of the engineering treatment of estuaries, viz., the regulation and improvement of the navigable channel and the protection of adjacent low-lying land from tidal inundation.

From the point of view of navigation, defects were stated to arise from three main causes: (1) a shifting, unstable channel, (2) a shallow bed, with inadequate depth of water, and (3) a bar.

Dealing with the shifting nature of the channel, examples were given from the Mersey, the Humber and the Seine. Certain principles were outlined for guidance in the carrying out of estuary training works, so as to avoid risks and possibilities attendant upon the confinement of the stream within a definite course. The design of different types of wall was considered, and the application of such walls to the mouths of the Mersey, the Ribble, the New Waterway to Rotterdam, the Venetian Lagoon, the Seine and the Whangpoo was described.

As regards shallowness of the river bed, the principal remedy, although not of a permanent nature, was stated to be dredging by means of floating plant of various types. Particulars were given of these and of operations carried out in the Thames, in forming the Yantlet Channel, and in the Clyde.

The cause and origin of bars was next discussed with special reference to the bars of the Mersey and the Gironde, and the peculiar conditions attaching to dredging operations in exposed situations were set out, with particulars of some of the latest and largest dredgers engaged on that class of work. The employment of jetties and piers for the concentration of the outgoing river current across the bar was illustrated by examples from the Tyne, the Wear and the Tees, with the results achieved.

Dealing with estuary embankments, the lecturer pointed out that in the case of the Thames alone, there were over 40,000 acres of serviceable marshland, utilised for a variety of purposes, which had to be protected at high water in this way, while, in the maritime provinces of Holland whole districts lay so low as to be permanently below sea level. The embankments on the Thames, the Trent and at the mouths of the Scheld and the Maas were illustrated and the nature of their construction explained, including the design of sluices for dealing with the drainage of inland water.

* A full report will be given in a later issue.

Notes of the Month

Harbour Dues at Newport.

It is announced that a motion urging the abolition of the allowance off harbour dues at Newport, Mon., will come before the Harbour Commission at their next meeting in January.

Radio Beacon for the Firth.

The Clyde Lighthouse Trustees announce that the installation of a radio beacon at Cloch is expected to be completed within the next month or two. The beacon should prove of considerable assistance to shipping in the upper reaches of the Firth.

Traffic on Great Lakes, North America.

The Great Lakes shipping season for 1937 officially closed on November 30th, with a total freight movement which constitutes a record. Although final figures are not yet available, it is known that the movement this year has been the largest since 1929, when 138,574,441 tons were recorded for five major commodities.

Increase in Clyde Revenue.

At a recent meeting of the Clyde Lighthouse Trustees in Glasgow, it was reported that the revenue for the year amounted to £17,044, an increase of £768 over the previous 12 months' total. The gross tonnage of shipping on which dues were paid was 16,528,558, an increase of 994,685 tons on the year. The total increase in revenue from rates, etc., was £748. The figures of revenue and shipping tonnage were the highest in the history of the Trust, and the surplus on the year's working amounted to £5,464.

East London (South Africa) New Turning Basin.

The new turning basin at East London was opened early in November on the arrival of "Athlone Castle," the largest ship trading in South African waters. After passing into the Buffalo River the vessel was berthed at the C.W. Malan Quay, making use of the 1,000-ft. turning basin in manœuvring into position. The basin was officially opened by the Minister of Finance (Mr. N. C. Havenga) who deputised for the Prime Minister.

Proposed New Free Port at Newfoundland.

The establishment of a free port at Mortier Bay, a large land-locked and ice-free harbour in the Burin Peninsula on the south coast of Newfoundland, is again under consideration, and it is hoped that a definite decision will result now that the Commission of Government takes a favourable view of the project. In addition to the advantages which the free port would appear to offer to international sea-borne commerce as a transhipment base for commodities bound for, or proceeding from, the St. Lawrence and Great Lakes, it should also prove beneficial to the Newfoundland fishing industry, particularly in disposing of fresh fish. Ships provided with cold-storage facilities would enable consignments to be sent up the St. Lawrence Waterway, long regarded as the approach to a great potential market, and probably to other parts of the world as well.

Baltwhite Timber Scheme: New Rates for 1938.

The Baltic and International Maritime Conference announce the issue of a new Tariff for the Baltic and White Sea timber trade during 1938. Since the last Tariff was issued there has been a considerable increase in the cost of various items which owners must take into account when working out their freights, such as operating expenses, wages, repairs and surveys, bunker coals, stevedoring, and also the shorter working hours introduced in some countries, resulting in vessels having to stay longer in the ports to discharge the cargoes carried. For these reasons, it has been necessary to increase the rates by 20-25 per cent. and adjust the port differentials according to the altered conditions.

Free Zone at Port of Galatz.

It has been decided to create a Free Zone on the left bank of the Danube, at the lower end of Galatz Port. An area of 500 hectares, forming a triangle of unoccupied land between the Galatz timber dock and the mouth of the River Pruth and bounded on the north by the Galatz-Reni Railway line, has been reserved by the Government. The Ports and Waterways Department, who are organising the zone, have decided, in the first place, to deal with only 15 hectares of the available land, and have selected an area, rectangular in shape, 500 metres long and 300 metres broad. The work will involve draining and levelling the ground, building a concrete wall to enclose the whole Free Zone, and providing a quay with berthing facilities for steamers and river craft. The river frontage will be divided into four berths, each 125 metres in length, with a levelled quay space extending to a depth of 150 metres. The remaining 150 metres will be available for the erection of warehouses, factories and other buildings as required.

New Docks Superintendent at Avonmouth.

Mr. G. T. Ryan has been appointed to the position of docks superintendent at Avonmouth and Portishead, to fill the vacancy occasioned by the death of the late Mr. H. K. Bubbear.

New Zealand Harbour for Flying Boats.

Mr. F. Jones, Minister in Charge of Aviation, has announced that the New Zealand Government has approved the appointment of a special committee to investigate the suitability of Wellington Harbour as a base for overseas flying-boats.

Capetown Harbour Development.

The South African Railways and Harbours Administration has accepted the tender of a Dutch firm, the Hollandsche Aanneming Maatschappij, for the Capetown foreshore development scheme. The tender amounted to a little over £1,125,000, and was the lowest submitted. It is expected the contract will take about 3½ years to complete.

Graving Dock Reopened at Falmouth.

No. 1 Graving Dock, which was the first to be constructed by the Falmouth Docks Co., was reopened at the end of November. The dock has been enlarged from 350-ft. to 555-ft. in length and from 50-ft. to 75-ft. in width. The three other graving docks at Falmouth have lengths of 537-ft., 611-ft. and 750-ft., and widths of 71-ft., 87-ft. 6-in. and 88-ft. respectively.

Proposed New Harbour at Ventura, U.S.A.

The Board of U.S. Engineers, War Department, have reported favourably on the project for a new commercial harbour and yacht basin at Ventura, California. It is proposed to construct a rock breakwater at an estimated cost of about 2 million dollars. Ventura at present handles about 2,000,000 tons of cargo per annum, chiefly oil and lumber, and has handled as high as 3,000,000 in 1929. It is expected that the War Department will make a detailed survey at an early date.

Tidal Air Base at Langstone Harbour.

The question of providing a tidal scheme in Langstone Harbour for Empire flying-boats has been raised by the Air Ministry, following the decision of Portsmouth City Council not to promote a Parliamentary bill which would have given it power to carry out a barrage scheme. At a recent meeting, the council adopted a recommendation of a committee agreeing to consider any further schemes and financial proposals the Ministry might put before the Corporation.

Albert Dock Hospital, London.

Owing to circumstances beyond their control, the Seamen's Hospital Society are faced with the task of finding a further large sum of money for the rebuilding of the Albert Dock Hospital. Much generous support has been given to the Rebuilding Fund Appeal, but an additional £12,000 is urgently needed, and the Society's Committee of Management are anxious that sufficient contributions shall be made to allow the new building to be completed and opened next summer free of debt. This hospital serves the needs of a typical dock district in East London.

Dredging at Geelong Harbour.

The programme undertaken by the Geelong Harbour Trust Commissioners to provide a minimum depth of 29-ft. at L.W.O.S.T. in the approaches and at the principal piers and wharves of the Port of Geelong is expected to be finished early this year. The dredging of the approaches has already been completed and very little remains to be done at the berths, but the work of lighting the approaches is being retarded by weather conditions. The draught to be fixed upon completion is dependent on the decision of the Pilots' Association, but it is hoped that this will be at least 27-ft. It is also proposed, as soon as the plant is available, to widen Hopetoun Channel to 300-ft., the same navigable width as the new channels.

Traffic on the Tees.

A surplus of £36,838 on the operations of the Tees Conservancy Commission for the year ended October 31st, 1937, was reported at the recent meeting of the Commission in Middlesbrough. Compared with the previous year, the accounts show an increase in the surplus of £16,499, revenue being higher by £12,887 and expenditure falling by £3,612. This is the fourth successive year in which the operations of the Commission have shown a profit. The total revenue for the year was £159,965, the increase being largely due to improved receipts from river dues and tolls, a larger number of vessels entering or clearing the river and increased imports and exports. The quantities of imported goods and materials exceeded last year's figures by over 335,000 tons.

The Port of Bordeaux and the Estuary of the Gironde

By M. F. LÉVÊQUE, Chief Engineer and Director of the Autonomous Port of Bordeaux

(Translated from the French)

(continued from page 55)

Flocculating and Stabilising Elements

It is necessary to call attention to an important point regarding the manner in which clay is held in suspension in water. Clouded waters clarify more or less quickly according to the nature and concentration of the substances in suspension. The introduction of certain electrolytes, called "stabilising" or "peptising," in suitable quantities, may increase the concentration of solids. Other electrolytes, called "flocculating," quicken the process of clarification by increasing the rapidity of deposit.

Matter in colloidal state is divided so minutely that the particles do not sink from their own weight: they tend to remain indefinitely in suspension until coagulated or flocculated by electrolytes in suspension. According to Holmes, the higher the valency of coagulating ions, the greater the effect of flocculation. This is shown by the experiments lately carried out by Prof. Pichot of Toulouse University, in the Gers tributary of the Garonne. The flocculating ions are mainly calcium, mangesium and a little sodium and chlorine; the deposit of the solid particles thus formed does not take place, however, until the horizontal velocity of the scouring current is very low. The water remains cloudy for a long time when calcium and the other elements named are only present in sufficient quantities. Ammonia from arable land, carried off by the rain, stabilises and even increases the solid contents of the water.

The nature and contents of the electrolytes dissolved in the water of rivers are therefore of the greatest scientific and practical interest. The dissolved substances contribute to the silting of rivers.

The decomposition of rocks is interesting from this point of view. Quartz remains unchanged. Felspar, such as that of the basin on the right bank of the Garonne, mainly resolves itself into hydro-aluminous silicates, oxides of various kinds and carbonates. Decomposition depends chiefly upon the presence in small quantities of certain very active elements, such as salts of phosphorus, of magnesium, of chlorine and of barium. Granites dissolve themselves into silica and carbonates of calcium, sodium and magnesium.

In soils are found organic matters, such as humus (from ½ to 3 per cent.) and an inorganic colloidal constituent, the ultra-clay of Whitney, comprising from 30 to 50 per cent. of silica.

Regions where the soil contains alkaline waters tend to lose a great quantity of silica in solution, whilst those where the soil contains acid waters tend to lose oxides of iron and aluminium. In the former case, iron and alumina remain in the soil, which then becomes one of the varieties of laterite. In the latter, the silica concentrates upon the surface of the soil.

In the Garonne basin, the origin of the various kinds of mud in suspension is generally indicated by the colour which they give to the water. As shown by M. Pardé in his valuable notice on the "Regime of the Garonne," recently published, the Tarn and the Lot receive from the Cévennes floods of a light reddish yellow colour. The Agout in flood is of a dark brownish yellow colour. The Lot, and particularly the Tarn, are at times almost blood red, which indicates erosion of the Permian clays of Espalion (Lot) and Albi (Tarn), or of the red or bright red tertiary clays which run from Castres to Albi. These clays contain much quartz with small white granulations and large reddish granulations, and are easily eroded. The Lot sometimes carries chocolate-brown, almost black, floods, which originate from the carbonifrous lands of Decazeville. The Avignon in flood is either light or dark yellow. The Haute Garonne in flood carries waters of a light greyish yellow colour, coming from the Pyrenees, or brownish waters coming from the tertiary deposits round about Naurouze and northward thereof.

Thus Bordeaux people can ascertain, from the colour of the water of their river, whence the flood which they fear is likely to come or the colour of the normal water which interests them.

The Role of the Catchment Basin

In order to ascertain the origin of the silt which circulates and deposits in the estuaries of rivers, it is necessary to study the composition of the ground which forms the basin and the elements, either stabilising or flocculating, which it contains.

The necessity upon which we insist later on of a connection between the internal basin of the estuary and the external marine basin also exists in the cases of the river basin and the catchment basin.

In order to stop the evil of silting, which only benefits downstream cultivation along the river's edge, such as that of artichokes, the problem must be looked upon in its entirety.

Recalling Theuriet's saying "a country without forests is a dying country," we must call again upon the forest to play, in the basins of the Pyrenees and Auvergne, its ancient role of creator of forest humus. As shown recently by M. Demoslaine in L'Urbanisme," the accumulation of detritus which forms this covering of humus is a matter of slow progress. During heavy rains, at least in the early stages, there is little run-off of the water from the soil owing to its absorption by the hygroscopic matter in the spongy covering of leaf mould. Absorption of the water is increased at the expense of the run-off, which is the cause of serious damage by scouring, principally in virgin soils.

The floods of 1930 in the basin of the Garonne caused much damage, and the same thing has happened since. The re-afforestation carried on alongside the tributaries of the Garonne has been too recent, and the covering of humus has not reached the stage where it could produce its proper effect. Fifty years at least are required to reconstitute a forest.

It has become necessary to restore the forests which have disappeared and also to prevent those which still exist from disappearing, but in order to obtain this result the matter must be dealt with on broad lines dealing with the problem as a whole.

Knowledge of the chemical composition of the soils of the catchment basin, to which reference has been made earlier in connection with the river water, will permit forestry experts to select the kinds of trees suitable for the soil and to take necessary measures for their protection. Without seeking foreign trees, like Danish beech, we can find in France trees which give back to the soil more than they take away from it. It has become necessary for us to combat erosion by the creation of new soil, so to speak, but for this purpose one must not overlook suitable undergrowth which has such vital importance in the production of the timber.

The afforestation of whole regions by means of appropriate trees is not a dream, since as M. La Mache lately pointed out in the "Revue Internationale Du Bois," the Northern woods, light and of slow growth, now cover regions which were in ancient times nothing but ice-bound steppes.

The long terraces which line the Garonne on either side must witness an attempt to recondition the soil. They were formerly covered by vast forests which excessive clearances, without plan or method, in modern times, and mainly in the 17th and 18th centuries, have impoverished and laid dangerously bare.

The proposed reafforestation of the catchment basins will require fuller study of the rainfall, which is here heavier than in the Loire and the Seine, and of the snowfall in the high mountains, which is less, however, than for the Rhone basin. Aeroplane surveys will also be required.

We may hope that one day a solution of the problem of the silting up of the lower part of the estuary may be found in the study of the tributaries which are most active in bringing down silt, and in the taking of measures to control erosion of their basins, either by reafforestation or by the construction of appropriate retaining works.

It may also perhaps become possible either to bring about the earlier deposit of matters in suspension in the water or else to bring them to such a condition of fineness and fixity as to ensure that they will be carried forward even by very weak currents, and thus will ultimately lose themselves in the sea.

Deposits in the Sea

The most minute particles of the clays in suspension in the Gironde are carried into the sea, after successive ascents and descents in zig-zag under the influence of tidal currents. The resultant in the Gironde is descent towards the sea, as the strength of the ebb-tide currents is much greater than that of the flood-tide currents. Most of the clays contain minute particles of sand, for quartz can be reduced, like pure clay or

Port of Bordeaux and Estuary of the Gironde—continued

kaolin, to extremely minute particles having practically the same density as the latter and thus remaining mixed with the clay during the process of sedimentation.

A very small part of this mixture of sand and clay is deposited against the internal face of the external bar or at relatively calm spots on the banks of Cordouan, or further to the South on the coast of the Landes. But the sea is too rough on the external bar to allow anything but the deposit of compact sand. The fine clay, more or less sandy, is carried away outwards into the sea.

When the movement of the sea is perpendicular with the coast, the carrying power of the water is generally too weak to bring about any important transport of matter. It is only when the movement is oblique to the coast that matter is carried by drift, following oblique trajectories in zig-zag on the bottom. The matter follows, forward or backward, the general resultant of the movement. Opposite the estuary of the Gironde, the waves during stormy weather are particularly active in that respect. During periods of calm, the only active waves are the bottom waves, which run generally normal with the coast, and tend to effect deposits on the shore. In stormy weather, when wind and the fall of the barometer have to be reckoned with, matter is kept in suspension in the water for long distances from the coast and to great depths. It must be remembered that waves can break on reefs or banks covered by some 40 metres of water and that the undulatory movement arising therefrom has great amplitude. As a matter of fact, in stormy weather, the sea becomes muddy all along the coast of the Landes, and this muddy condition may persist sometimes for a very long time after the storm has abated.

The speed of deposit of substances in suspension varies according to their size, shape and specific gravity. Thus, it has been ascertained that gold particles of 1 micron sink in water at the rate of 2½ mm. per minute. Quartz of 10 millimicrons, on the other hand, only sinks at the rate of 1 mm. per month, a rate of sinking which is obviously easily neutralised by the slightest current. The same effect is noticed in the case of certain dust clouds raised by the wind to a height of many hundreds of metres and carrying minute particles of impalpable clay and quartz—such as the wind called " Khamain " on the Gulf of Tajurah on the Red Sea. In this way are constituted the terrigenons deposits on the Continental shelf, which automatically move outwards the neutral line of Cornagalia and arrange themselves on the sea bottom in accordance with the mechanical energy of the waters in contact with them.

In front of the Gironde estuary tidal currents are noticed which, although powerless to carry any appreciable quantity of sand outside the bar are nevertheless quite strong enough to carry in suspension minute particles of clay and quartz. A current of 10 cm. per second erodes arable land; one of 20 cm. per second is strong enough to erode clay; materials of the size of a pea are set in motion by a current of 80 cm. per second, and pebbles of the size of a hen's egg require a current of 1.70 m. per second.

Currents of 1 knot (51 cm. per second) are frequent to seaward of the Gironde. It is probable that in the offing, northward of the estuary, the resultant of the tidal currents is in the neighbourhood of the S.-N. direction. Part of the waters carrying matter in suspension—at least those which are not too far from the Charente coast—goes definitely northward. It is then caught by the current of the flood which enters by the narrow channel of Maumusson, which divides the mainland from the island of Oleron, and through which powerful currents run carrying from 5 to 6 million cubic metres per tide. These waters with matter in suspension are swallowed up in the space, shaped somewhat like an eel-trap, lying between the mainland and the islands of Oleron and Ré. In the calm zone which they have then reached, they settle down and deposit and form those important and continuous maritime alluvial deposits called locally " bri," which silt up the mouths of the coastal rivers, the Seudre and the Charente, and then, north of La Rochelle, the ancient Gulf of Poitou, which had formerly a surface of 400 sq. kilometres and which is now reduced to the Aiguillon bay.

Plains with only a slight declivity are now met with in those regions—for instance, 3 centimetres per kilometre, which is a fairly common slope (50,000 hectares in Loire-Inférieure; 31,000 in Vendée; 6,000 in Deux-Sèvres; 113,000 in Charente Inférieure), a total of some 200,000 hectares, of which 15 per cent. is covered with water. Damming and drainage operations in the district have been carried on since the XIth century, and were particularly active during the XVIIth century, under Henry IV. and Colbert, with Dutch engineers, notably Humphrey Bradley.

The deposits from the Gironde are perceptible up to their meeting point with the less important deposits from the Loire, in the direction of the Sables d'Olonne and no doubt farther away, in the offing of the Continental plateau widened towards the Petite Sole.

The waves caused by storms from the South-West, and from which the southern region at the rear of the island is not protected, as well as those from the North-West which run through the channel of Antioche—where the sea is moved more deeply in stormy weather than almost anywhere on the French coast—are most active in carrying into the eel-trap of La Rochelle minute substances which can hardly get out of it.

The deposit of those matters in suspension advances the coast line into the sea by 50 centimetres per year by means of regular deposits which attach themselves, as in the Medoc, to limestone beds, such as those of Marans and Arbert, round which they are progressively deposited at low tide and then extended and consolidated.

In order to form an idea of the quantity of matter which the Gironde sends on to the Charente coast, it would be necessary to establish a comparison between the sea bottom and the shores by means of hydrographic surveys, but one would be compelled to admit that no eustatic movement occurs under our eyes. No such surveys have yet been attempted, though for them the new " echo " sounding apparatus would be found very useful.

Material Dredged from the Outer Bar on its Outer or Seaward Side.

But we have undertaken another interesting study, that of the quantity of materials of all kinds which are deposited within the interior of the estuary of the Gironde and up the river. (Note.—As regards the river, it has been found that, over a length of 30 kilometres down river from Bordeaux and over a period of 24 years, 500,000 cubic metres of alluvium is deposited yearly, which is removed by dredging. Under the bridges of the Loire at Nantes, something like 500,000 cubic metres of sand is also carried yearly, of which only part is dredged. As a matter of comparison, 2,000,000 tons of mud are brought to Geneva yearly by the Arve River from Mont Blanc).

In order to ascertain the quantities, it is only necessary to calculate the cube of the deposits on the river bed as shown by the sounding charts at various dates during the period of time. The figures should then be compared with those of the substances carried in suspension down and up river, and which give the total of the capacity of sedimentation of the Gironde.

On this important point, however, we have so far only insufficient data as to the difference between carriage by the ebb and carriage by the flood during tides with varying co-efficients. All that we know for certain is that on balance there is a large excess in the carriage of material down river.

After ascertaining the figures of internal deposits and of those along the Charente coast, it will no doubt be possible to find the quantity which is deposited out to seaward on the continental plateau.

Our study will next be directed to the bar of the river.

THE OUTER BAR AND THE NEW CHANNEL

The Fluvial Character of the Bar

The bar remains firmly consolidated in sand more or less shelly, more or less fine, brownish and sometimes greyish, and coming doubtless from the large dunes and, in view of the sand, from the Landes, which border both sides of the mouth of the river.

Port of Bordeaux and Estuary of the Gironde—*continued*

From soundings by dredger, this formation persists to at least 18 metres below the low-water zero of marine charts. The old channels had a bottom depth of 15 to 20 metres by a width of more than one kilometre at about the location of the new channel.

It is found, for instance, from Magin's soundings carried out in 1752, that the channel of that time, although far from being rectilinear, was developing in polygon shape, round what is now our western synthetic rectilinear channel.

Is the bar caused by the sea or by the river? We shall see that whilst almost exclusively marine, as judged by its granulometric formation, it is fluvial by its currents and marino-fluvial by its variations and by the conditions of its permanence in space and time.

Material Dredged from the Outer Bar, near the Middle.

Nature of the Bar Bottom

The Great Bank is exposed on its seaward face to storm waves. In consequence, the granular elements forming the semi-circular pad, which is the Gironde's first line of defence against the ocean, are rather large, and comprise notably a large proportion of shells. Towards the centre of the pad, these elements become progressively smaller and finer, especially the silicious elements, sand or shingle.

Towards the interior margin of the pad, the dune sand which constitutes the bulk of it is often continued by a fine, very grey sand, which indicates a reduction in the velocity of the currents over the bottom, once they have crossed the obstacle formed by the bar. There is no difference in the chemical constitution of the elements just described. They are only differentiated by their susceptibility to movement under the motive powers of the attacking forces of nature.

A few mud banks, of small size and very shallow, are also formed, which correspond to calm regions in the sea. But this is only an accident which goes to confirm the general basis of the formation of the Great Bank.

The Bank is therefore, like the "ridens" undulations of the fan-shaped submarine dunes in the North Sea, near Dunkirk, and like the "directed" dunes of Lybia, a submarine dune which has grown in a shape (in this case semi-circular) due to the resultant direction of the forces constituting it.

Acidity—Salinity

The numerous studies of currents which have been carried out between Le Verdon and the outer channel, have established in a most convincing manner, like the studies of salinity, that the fluvial character of the waters does not disappear at Pointe de Grave but only in the external convexity of the bar.

The salinity problem has already been closely studied. The weight of salt dissolved varies from 30 grammes per cubic metre in the neighbourhood of Pointe de Grave and the bar, to ½ a gramme at Bordeaux and 1/50th of a gramme 50 kilometres above Bordeaux. The weight varies according to tidal coefficients, and even according to the time of the tide, at any given point. The salinity of the sea is from 32 to 33 grammes to seaward of the bar.

The salinity of the muddy waters of the Gironde cannot be determined by the indication of hydrogen. No account would be taken by this method of certain elements which relate to flocculation and have a considerable importance in the Gironde.

A practical study of the variations of salinity may be carried out by means of numerous measurements of electrical resistance, and such measurements are being made by M. Glangeaud of Bordeaux.

Biological studies have also been commenced.

In fact, the waters of our estuary are continental waters, generally of low temperature and weak salinity. They run at a considerable distance into the waters of the Atlantic, whose more or less periodical fluctuations and the corresponding migrations of fish, together with the plankton, are being studied by the French School of Hydrography, especially by M. Le Danois and Professor Legendre.

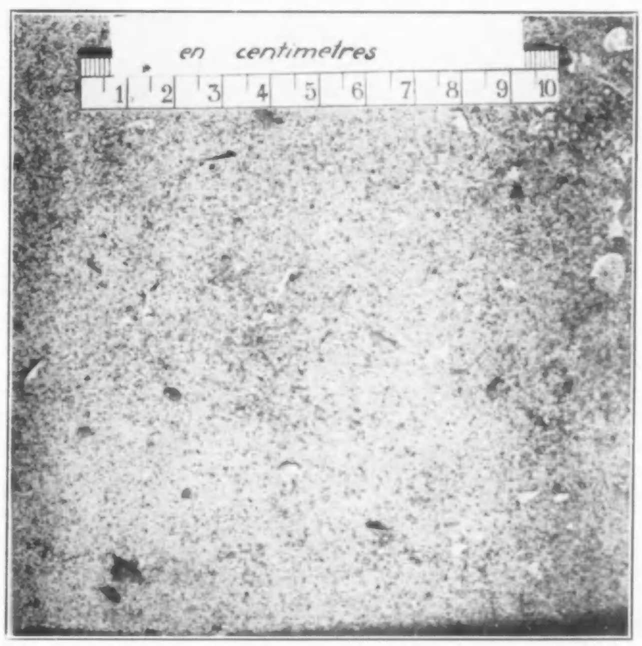
The Crescent of the Bar

From the morphological point of view, the bar forms a submarine crescent perfectly regular in shape, which rests southward on the reef of Cordouan—the line of breakers marking the western limit of those rocks of Cordouan, which must always be considered as united by a solid sill with the Pointe de Grave, and northward on the sandy point of La Coubre, which is the connecting link between the general N.-S. coast of the Atlantic and the clay cliffs of Saintonge, and which is probably seated upon a limestone promontory.

This crescent-shaped pad, called the Great Bank, is a submarine shoal, rather steep on the seaward face, where it is exposed to storms. It encircles internally a zone of deep water, relatively calm, the centre of which is the point of La Coubre. This depression is at the outer end of a trough of considerable depth, reaching from 25 to 30 metres below zero (low tide) running along the cliffs of Saintonge to the up-river side of Pointe de Grave and the Verdon roads.

Study of Currents

The study of currents is carried on all over this zone by weighted floats of a given depth, which indicate the conditions of navigation of a ship of similar draught, and by special floats designed for the study of currents on the sea bottom. Variations of direction and of intensity of currents have also been studied by means of weighted floats at selected points along the channel and over the banks. Tests have been made both at the ebb and at the flood, and on tides with variable coefficients from 30 to 110. The results have been recorded by means of



Material Dredged from the Outer Bar on its Inner or River Side.

graphs, which disclose the following characteristics of tidal currents in the estuary.

1.—Up to the external face of the crescent-shaped bar, currents of ebb and flood follow more or less the same straight line, the turning of the current taking place very rapidly. The bottom currents give similar results.

2.—The speed of ebb currents is generally greater than that of flood currents, often double that of the latter.

3.—There is a fan-shaped development of all currents over the estuary, between the Coubre and the Medoc Coast, and especially over the crescent of the bar where the dispersion of direction of the currents presents regular features, resulting from the diameters of the curve of the external bar. Currents decrease in intensity when proceeding from the interior to the exterior of the bar.

4.—Extremes of speed vary from a fraction of a knot to 4.5 knots (1 knot = 51 cm. per second), apart from exceptional upland floods.

Port of Bordeaux and Estuary of the Gironde—continued

By means of experiments with anchored floats, it has been ascertained that the currents, which follow more or less the same straight line so long as they have not crossed over the seaward side of the crescent-shaped bar, assume the character of sea currents almost immediately after crossing, that is to say, they take all directions in succession around one point. We find there the commencement of the marine regime, which, however, is less pronounced towards the North, owing to the influence of the coast, which causes a preponderance of ebb currents in the northerly direction.

Layers of currents, clearly distinguished from adjacent waters by reason of difference of salinity, are also frequently met with: such, for instance, as the "blue sea," as seamen call it, which may be seen in the muddy waters of the estuary and particularly in the new entrance channel.

It should be noted that heavy floods in the river influence the ebb as far as the bar. This matter is the subject of further study, but we may say that, from careful observations made in 1935, on the occasion of a very strong tide (coefficient 117) and of an exceptionally great rise in the rivers flowing into the basins of the Garonne and the Dordogne, it was found that, opposite the Pointe de Grave, the ebb current, normally of an average speed of 2 to 2.2 knots, reached at its maximum 5.4 knots (or 2.72 m. per second). This is important as explaining the carriage into the sea of colloidal muds not yet sufficiently sedimented and the maintenance of depth in navigation channels by natural scour.

The Recent Series of Geographical Positions of the Submarine Bar

We have made use for this study not only of old pilot charts and old maps (dating from 1545 to 1752), but also of the Reports of the Mission of Hydrographical Surveyors of the French Navy already mentioned (dating from 1825 to 1924); the annual returns of the Hydrographical Services of the Port of Bordeaux and other various studies carried out by the authorities of the port.

The changes in the sandy bottom of the Great Bank are slow. At a given point, from year to year, the change in height does not exceed 5 to 10 centimetres annually. In order, therefore, to appreciate the bearing and course of the phenomena, it has been necessary to go over fairly long periods of time.

The Isle of Antros and the City of Noviomagus

We shall only take into account phenomena of which there exist reliable records. We shall not examine whether—as seems to some to be intended in the works of the latin geographer Pomponius Mela (1st Century) or of Ausonius and Ammianus Marcellinus (4th Century)—the Peninsula of the Medoc (Meduli) ended towards the North, facing La Coubre, with a large island, Antros (Celtic = the leaper) varying in dimension with the state of the tide, and including the rocks of Cordouan. This island would appear to have been situated between the main channel on the Charente side of the Gironde and a secondary passage, the channel of Soulac, on the shores of which is said to have been placed the vanished sea-board town of Noviomagus, and the town of Dommoton, where lived Theon, that friend of Ausonius who was in the habit of sending him oysters from the locality. We can only say that the existence of the Isle of Antros and of a sea shore to the south of the island, advanced further seaward than the present shore, is not incompatible with the present topography of the Medoc or with the theory of the dunes and ancient shores which has already been referred to.

In Modern Times

Limiting ourselves to the information given by the fairly reliable documents published since 1677, we find that the channel begins with a period of formation and regularisation during which, far to the seaward, a number of banks called "ânes" (asses) existed, which had disappeared, so far at all events as the farthest ones were concerned, by the end of the 17th century.

In our study, however, we must not dissociate the outer estuary which is subject to the fluvial regime of tidal currents from the inner estuary properly so-called. The outer bar is affected not only by storms but also by ebb currents, which are the strongest of the tidal currents, and those depend upon the general channels of the estuary, and accordingly upon the silting of the river which in its turn depends upon the catchment basin. So long as the river itself has not reached a sufficient advanced stage of progress towards practical hydraulic equilibrium, important concurrent variations will result in the external estuary and even in the bar itself. Unfortunately the old maps, such as that of 1677, do not give accurate information regarding the interior of the Gironde, but the phenomenon is shown clearly on the complete surveys of the 19th and 20th centuries, which cover the river up to the neighbourhood of Bordeaux. In addition, the examination which we have carried out has borne particularly upon the navigation channel. We have gathered much useful information in the matter from the work of Count Calletti on the movements of sea bottoms under the complex influence of the many causes, regular and irregular, which affect them.

From 1792 to 1825, the navigation channel cut the Great Bank in the sector 75 W.-N. The channel then had, between the contours of a depth of 10 m. below zero, a width of over 1 kilometre, with an average depth of 11 metres at low water.

Since then, it has gradually developed northward by the swinging of its axis around a centre close to the Pointe de la Coubre, in the main channel.

Further, a progressive silting was noticed at the same time as the channel ceased to be rectilinear (for its seaward opening was pushed northward) to transform itself finally into a VV (double vee) with points dangerously close to the coast. This northern channel was dreaded by pilots for, in storms from the S.-W. the big waves from the sea, having crossed the bar, form themselves into trains of three waves in close succession which do not allow medium-sized vessels to manœuvre, but carry them on the reefs of the coast of La Coubre. The width and the depth of the channel had decreased from 1,100 metres width and 10 metres depth in 1825 to 400 metres width and 7 metres depth in 1930.

In the ascertainment of these phenomena, we have used the method employed by hydrographical surveyors to find the variations of depth by means of cross sections: the differences in volume are shown by the contours of level on coloured plans where, for instance, the zones eroded are coloured brown and those silted coloured blue. This method shows clearly the progress of the phenomena. It permits of the termination, in given circumstances and at any given time, of the neutral line of Cornaglia, as seen by Thoulet.

We have superposed, upon each of the characteristic isobaric contours of 5 m., 8 m., and 10 m. below zero, the results of successive surveys, and we have found, with only slight variations in relief, a remarkable stability of these contours in space and time, since 1853. The seaward face of the crescent of the bar, in particular, is now practically stable and regular. We may therefore conclude that we have reached a sufficient degree of stability to warrant the undertaking of heavy and costly works.

Winds and Storms

After thus studying what happens in the water and under the water with regard to currents and to the bottom of the external estuary, we have examined the other characteristic element of the problem, that is, the action of the wind and the correlative action of storms.

As regards wind action, we have had at our disposal the old and continuous records of the Lighthouse Authority at La Coubre, Cordouan, Royan and Pointe de Grave; we have closely examined the very detailed records of observations, though hitherto not very numerous, carried out by the Autonomous Port in the outer harbour of Verdon. We have also found in a notice by Commander Rouch most interesting information which we have compared with that obtained at Royan and given in Partiot's Note on Estuaries, in 1892.

The result of the information obtained is that, considering only the stronger winds, which are the only ones causing or corresponding to waves capable of appreciably affecting the bottom at the bar, westerly wind is predominant. The number of storms in the sector S.W. to W. is slightly superior to that of storms in the W. to N.W. sector, although gusts of wind from N.W. are among the most violent. The disturbing action of storm waves is thus predominantly in W.-E. direction, and there seems to be equilibrium of resultant between the sectors N. and S. round this average direction W.-E. of maximum intensity.

We have now the elements of knowledge which will enable us to explain clearly the character of the outer bar of the Gironde. What is this bar? It is merely the result of the ceaseless conflict between sea and river. The sea drives back towards the land the moving mass of debris derived from the coastal dunes and other marine detritus, which it keeps in constant motion down to great depths. The river drives out as far as possible its waters and its alluvial matter and pushes them back against the organic mass which the sea is driving landward. Yet, as we have shown, the bar includes in its composition only a small proportion of elements brought down by the river.

The bar constitutes a real delta, in the true sense of the word and as regards shape.

Storms are the force which prevents this submarine delta, of typical shape, from progressing westward, and which have made it into an anchored or "blocked" delta. The substances brought down by the river would increase this delta if they were not carried to and deposited on the continental floor or the coasts of Charente by the effect of the movements of the sea. In fact, the delta is remarkably stable as regards its general position, although from time to time it has undergone local variations in shape and height.

(To be continued).

New Quay at Arzew, Algeria

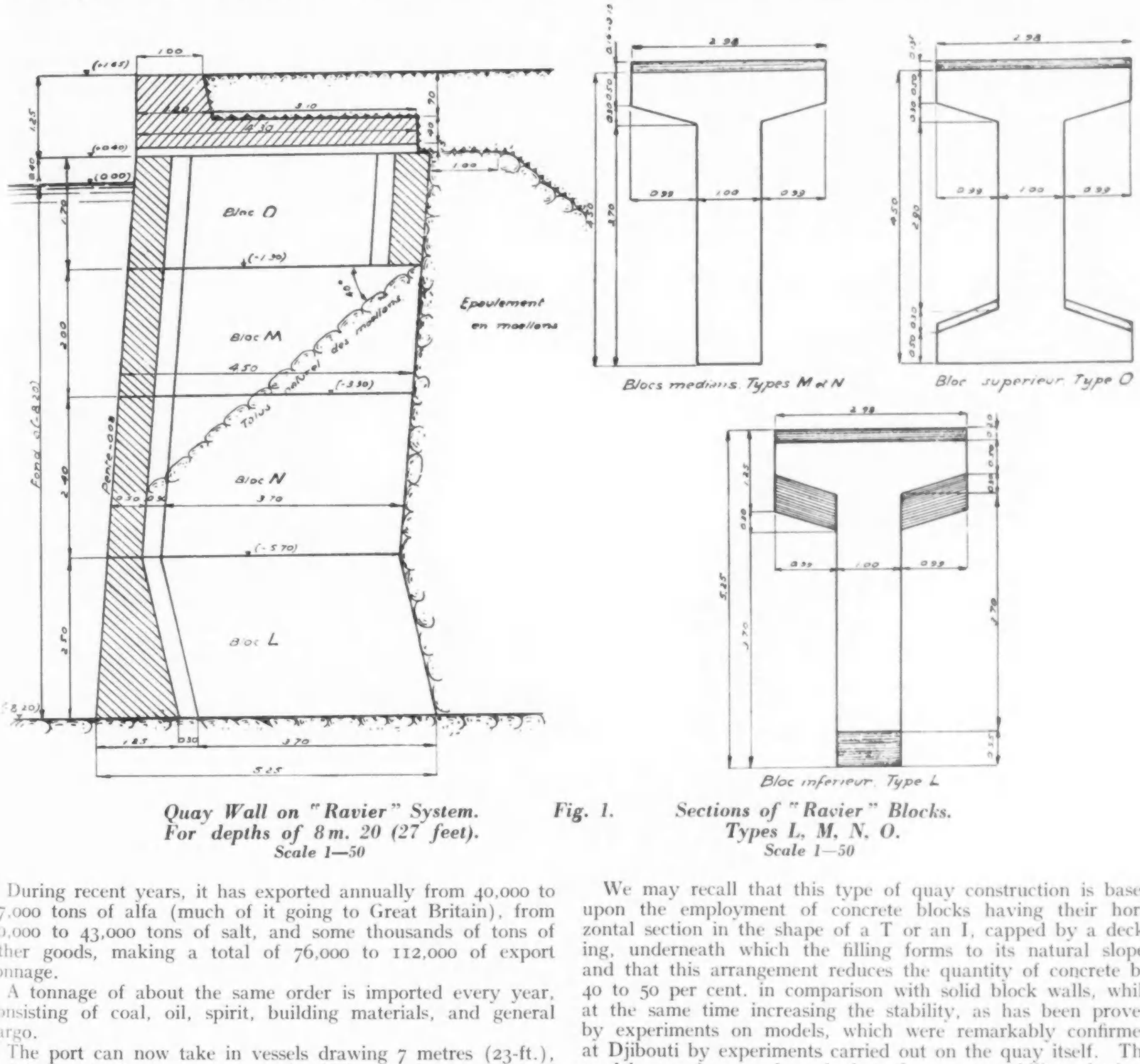
By LOUIS RAVIER, Ancien Ingenieur Principal du Genie Maritime

THE Port of Arzew, in Algeria, is a second-class commercial and fishery port, situated about 20 miles East of Oran, accommodating vessels up to 3,500 n.r.t.

It is reached from Algiers just before reaching Oran by way of the long railway, the Sud Oranais, which extends as far as Figuig, about 400 miles, and Colomb Béchar, about 450 miles distant.

It serves mainly as an exporting port for "alfa," a plant used in paper-making, and for salt derived from local salt-pans.

blocks. This system had previously been employed by the same Company, in 1933-4, for the construction of a quay, 250 metres long and 10 m. 40 to 12 m. 40 (34 to 41-ft.) high, with 9 to 11 metres depth of water alongside, at Bone, which is also in Algeria. Another company, the Batignolles Construction Company, had employed the system for a quay 210 metres long and 11 m. 30 high (with 8 m. depth at low water) at Djibouti, in French Somaliland. These earlier quays were described in the French journal "Travaux," of November, 1934, and in "Engineering" of 14th June, 1935.



Quay Wall on "Ravier" System. For depths of 8 m. 20 (27 feet). **Fig. 1.** *Sections of "Ravier" Blocks. Types L, M, N, O.*
Scale 1—50 Scale 1—50

During recent years, it has exported annually from 40,000 to 57,000 tons of alfa (much of it going to Great Britain), from 30,000 to 43,000 tons of salt, and some thousands of tons of other goods, making a total of 76,000 to 112,000 of export tonnage.

A tonnage of about the same order is imported every year, consisting of coal, oil, spirit, building materials, and general cargo.

The port can now take in vessels drawing 7 metres (23-ft.), and its good railway connections should lead to further development.

The fish traffic in 1936 amounted to 930 tons.

There is a favourably situated natural roadstead, and, in 1934, works of improvement were commenced to afford greater shelter. These consisted in extending the East Jetty from its former length of 300 metres to about 700 metres (2,300-ft.), for protection of the harbour from the East winds to which it was exposed, and in the creation of an entirely new South Jetty, 940 metres (3,080-ft.) long, to arrest the drift of sand.

Over a great part of the large water area, which is thus enclosed, there will be a depth of from 6 to 9 metres (20 to 30-ft.), and at the entrance more than 11 metres (36-ft.).

After building the jetties, it was necessary to lengthen or create several moles or quays. As the construction of these called for the manufacture of a large quantity of artificial blocks, and it was desired to facilitate the casting and handling of these blocks by forming a block-yard, arranged as conveniently as possible, the works were begun by widening and lengthening an existing mole, called "No. 3."

The Léon Ballot Algerian Contracting Company, who were entrusted with the work, proposed, and were allowed to adopt, for the economic execution of this work, the "Ravier" system of "compound" quay walls formed of specially-shaped hollow

We may recall that this type of quay construction is based upon the employment of concrete blocks having their horizontal section in the shape of a T or an I, capped by a decking, underneath which the filling forms to its natural slope, and that this arrangement reduces the quantity of concrete by 40 to 50 per cent. in comparison with solid block walls, while at the same time increasing the stability, as has been proved by experiments on models, which were remarkably confirmed at Djibouti by experiments carried out on the quay itself. The model experiments showed that the great stability obtained was largely due to the hold exerted on the blocks by the backfilling which surrounded and embedded their tail ends.

At Arzew the same designs were followed as for the quays at Bone, except for adapting them to the lesser heights and calculating on a surcharge of 6 tons per square metre instead of 5 tons at Bone and Djibouti.

The walls vary in height, the quay level being uniform throughout at 1 m. 65 (5-ft. 6-in.) above mean sea level, but the depths under water differing, as follows:—

	Length	Depth of Water
East Quay, extension ...	95m.	8m. 20
South Quay, at end of Mole	100m.	8m. 20
West Quay, New Frontage	83m. 80	8m. 20
	63m. 60	6m. 80
	57m. 60	5m. 80
	84m. 80	5m. 20 to 3m. 20

Fig. 1 shows a typical cross-section of the quay and the plans of pre-cast blocks for quays having depths of water of 8 m. 20 and 5 m. 80 respectively.

There are two types of blocks: long ones for water depths of 8m.20 and 6m.80, and short ones for depths of 5m.80 or less.

An endeavour has been made to suit the variations in depth by employing a limited number of block types with the same base outline, but of differing heights.

New Quay at Arzew, Algeria—continued

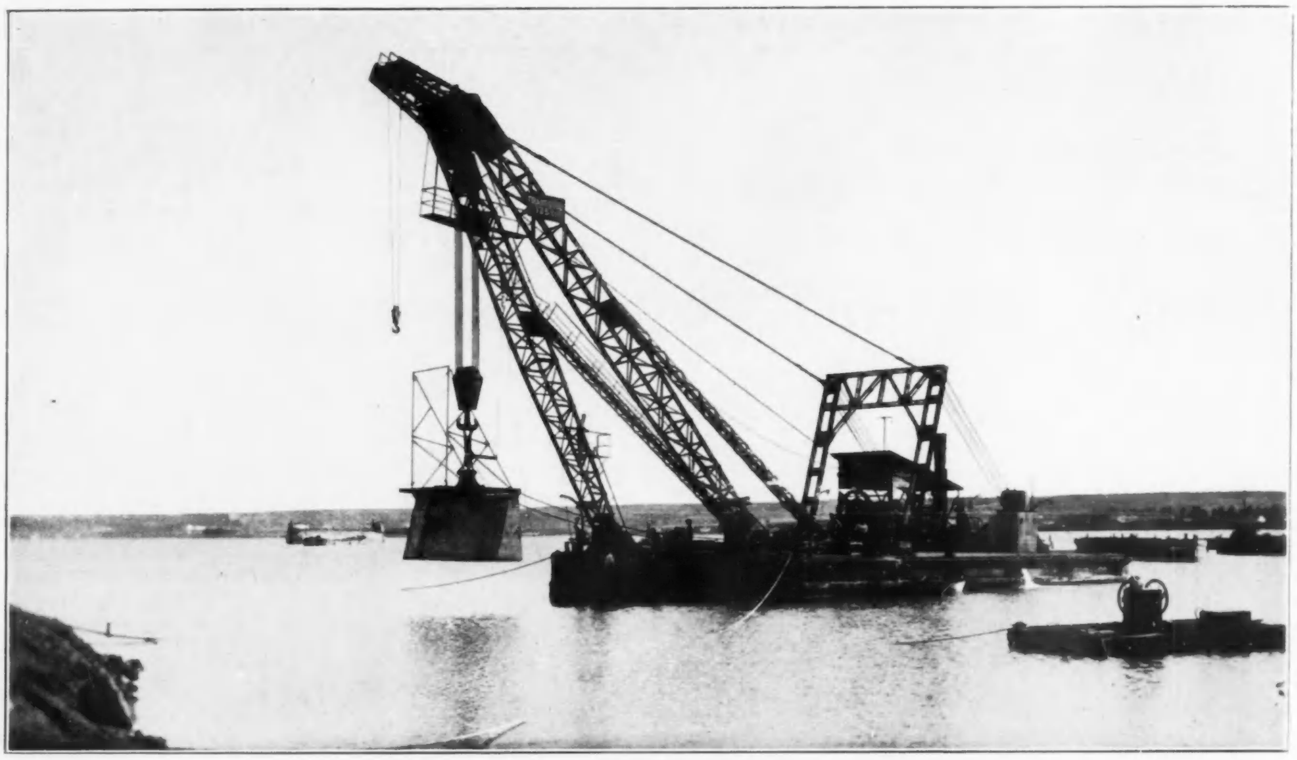


Fig. 2. Placing Blocks for No. 3 Jetty. September 20th, 1934.

The blocks are of cement concrete, made with 230 kilograms of cement to the cubic metre (6 to 1), and are not reinforced. They were cast in metal moulds, thus assuring an easy and accurate finish at a cost per cubic metre practically equal to that of ordinary rectangular blocks. They are all 2 m. 98 wide and built up as vertical piers with 5 cm. clearance between them, so that the spacing of piers is at 3 m. 03 centres. The capping slab connects the tops of the piers together, and carries the bollards, the weight of which and other forces acting thereon are thus distributed over several piers of blocks.

The form of the blocks in T or double-T shape permits of handling them by grips holding the central portion instead of by chains passing under them. This rendered the fixing easier and more rapid, with less labour.

A photograph (Fig. 2), taken on 20th September, 1934, and here reproduced, shows the block-setting floating crane about to lower a block into place. In this, there can be seen the pairs of grips holding the block by its middle. There can also be seen a light framework of steel tubing, built up from the block and high enough for the top of it to stand above water when the block is lowered into place. This enables the positions of the blocks to be regulated, when submerged, by simple observations taken above water.

The first blocks were moulded on the side of the existing No. 3 Mole, from whence they could be lifted direct by the floating crane.

Another photograph (Fig. 3), taken on 1st March, 1935, shows the larger block-yard which was afterwards formed on the mole, by this time partly enlarged. Only the blocks on the right could be lifted direct by the floating crane from the moulding yard. The others had to be first transported to the end of the mole by the travelling gantry crane, seen on the left

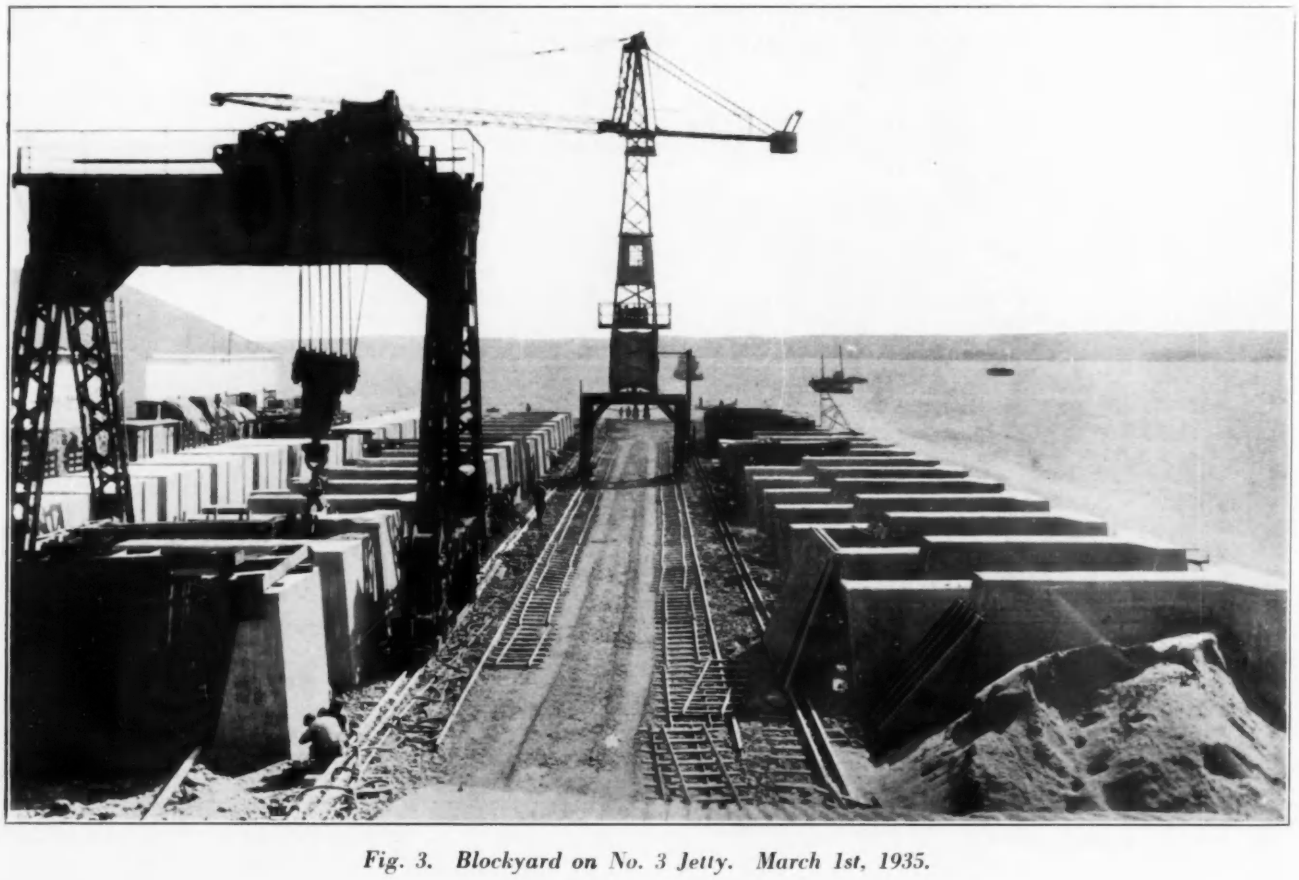


Fig. 3. Blockyard on No. 3 Jetty. March 1st, 1935.

New Quay at Arzew, Algeria—continued

Fig. 4. Port of Arzew. General View of No. 3 Jetty. May 21st, 1936.

in the photograph, and under which can also be seen the block being handled with a pair of grips. The floating crane then came and picked them up at the end of the mole.

The gantry crane, of cantilever type, high lift and light construction, seen in the same photograph, served for handling the forms and for the transport of skips of concrete.

The third photograph (Fig. 4), taken on 21st May, 1936, shows the mole completed and brought into use along the right (or West) side as a yard for the making of blocks to be used in construction of the jetties, with contractors' floating plant lying alongside the right (or West) quay and the end (or South) quay, while at the left (or East) quay is moored a cargo vessel engaged in trade.

The quays in question have thus been in service since early in 1936, and giving full satisfaction.

Another quay wall on the same system, but having a height of 12 m. 90, with a depth of 9 m. 40 at low water and 750 m. long, is in course of construction as the main quay at the Port of Pointe Noire (Black Point) in the French Congo. This is a new harbour that is under construction to form the terminal of the recently completed French Congo-Ocean railway.

The system has also been recently adopted for a quay, 244 m. long and 11 m. high, with 9 m. depth of water, which is to be built at Mostaganem, a small port in the same part of Algeria as Arzew, and about 80 kilometres (50 miles) from Oran.

The Reconstruction of a Thames Bridge

A Paper on "The Reconstruction of Chelsea Bridge," by Messrs. E. J. Buckton, B.Sc. (Eng.), and H. J. Fereday, M.Inst.C.E., was read before The Institution of Civil Engineers on Tuesday, 14th December. The Paper dealt with the replacement of a suspension bridge, typical of 80 years ago, by an essentially modern structure. The decision to adhere to the suspension type of bridge was influenced, on account of the effect on the river traffic, by the adjacent 4-span railway bridge, the openings of which had originally been planned to suit the old suspension bridge. The placing of the new piers on the site of the old also simplified reconstruction. As the existing land anchorages were inadequate and their replacement by others would have been expensive, the self-anchored type of bridge was adopted. In this type the cables are anchored to the ends of deep stiffening girders, which run from end to end of the bridge. An unusual feature in the new bridge was the omission of the portals usually constructed at each pair of towers, the necessary lateral support for the towers being, in this case, provided beneath the roadway.

In a suspension bridge of the self-anchored type, it was necessary to complete the stiffening girders before cable erection was commenced, and temporary supports to the stiffening girders were therefore required until their weight could be transferred to the cables. The side spans of the new bridge were sufficiently strong to carry their own weight between end bearings, but a temporary mid-support had to be provided for the centre span. In view of the requirements of river traffic, the flotation method of erection was adopted. The Paper describes the demolition of the old bridge and the construction of the new one, and particulars are given of the fabrication of the steelwork and the manufacture and pre-stressing of the suspension ropes. Some figures of cost are given, and comparison is made between æsthetics of the old and new bridges.

Publications Received

Lloyd's Calendar is too well known to require any introduction, and the 1938 edition is well up to the standard of its predecessors. The number of tide tables has been increased, and they now provide times of high water for some 60 ports. Other fresh matter includes new articles on the sextant, echo sounding, record voyages of sailing ships and North Atlantic liners, the coal export trade, shipping values and oil industry. The whole of the original work has been thoroughly revised, with the addition of several new interest and percentage tables. The Calendar is issued by the Corporation of Lloyd's, London, E.C.3, at the price of 3s. 6d. per copy (postage extra).

Messrs. Stothert and Pitt, Ltd., Engineers, Bath, England, have recently published a well-illustrated brochure giving a pictorial record of the various designs of Electrical Lifting Plant, which they supply to meet the local conditions of undertakings requiring the use of cranes. The brochure deals principally with the lighter types of Cargo Handling and Grabbing Cranes with lifting capacities up to 10 tons at varying radii, and it is pointed out that publications dealing with other types of heavy-duty cranes and lifting machinery, such as Titans, Hercules and Dry Dock Cranes with lifting capacities up to 300 tons, are also available.

Mackay Harbour Board, Australia

Excerpts from the Anuual Report

Financial

The Statements of Accounts are for the financial year 1st January to 31st December, 1936.

The revenue amounted to £25,516 0s. 1d., of which the sum of £24,417 9s. 5d. was collected for Harbour Dues (being an increase of £6,182 9s. 4d. on the year 1935), £80 0s. 0d. for Contractors' Deposits, £870 5s. 0d. for Rents, and £148 5s. 8d. for Sundry Receipts.

The increase in revenue from Harbour Dues is mainly accounted for in Outward Raw Sugar, 172,474 tons having been shipped during the year 1936, compared with 108,767 tons during the year 1935.

Eliminating Outer Harbour expenditure the revenue exceeds the ordinary expenditure by £20,953 17s. 10d.

Expenditure may be summarised as follows:—

Administration	£2,598 17 10
Maintenance	714 7 9
Other Expenditure	1,248 16 8
	£4,562 2 3

All old Treasury Loans have now been liquidated.

Surplus revenue has been utilised in the financing of the Outer Harbour construction, and to the 31st March, 1937, the sum of £29,500 was used for this purpose.

Shipping

The total arrivals of vessels in the port during the year ended 31st December, 1936, numbered 231, with a registered tonnage of 515,825, comprising overseas vessels 31 with a registered tonnage of 109,059; inter-state vessels 122 with a registered tonnage of 376,022; intrastate vessels 78 with a registered tonnage of 30,744.

This is an increase of 32 vessels with a registered tonnage of 75,691 over the year 1935.

Trade

During the year ended 31st December, 1936, the inward cargo amounted to 36,081 tons 6 cwts., and the outward cargo 6,298 tons 15 cwts., compared with 37,166 tons 19 cwts. inward, and 6,158 tons 2 cwts. outward for the year 1935.

Compared with the year 1935, inward cargo shows a decrease of 2.92 per cent., whereas the outward cargo shows an increase of 2.29 per cent.

Harbour Facilities

The Harbour Scheme now under construction consists of an enclosed harbour, 140 acres in area, protected by a southern and northern breakwater of rubble stone with a concrete capping. The stone is obtained from Mount Bassett, 70 chains distant from the root of the southern breakwater. Originally, wharfage accommodation was to have been provided along the southern breakwater with future extensions in the form of three piers to be constructed as required, but this procedure has been departed from; and the construction of the first of the three piers is being proceeded with instead.

There is a natural depth of 30-ft. at low water of spring tides at the entrance, 600-ft. wide, there being a maximum tide range of approximately 20-ft. The swinging basin is to be dredged to 24-ft. at L.W.S.T., and the berthage to 33-ft. at L.W.S.T., which at neap tides represents 38-ft. 7-in. and 47-ft. 7-in. respectively at high water. At high water of spring tides the depth at the berthage will be about 54-ft. and in the swinging basin about 45-ft. The harbour will accommodate the largest vessel visiting Queensland ports.

Site

The site selected is about two miles north of the mouth of the Pioneer River, and is being connected by rail and road with the city about 3½ miles distant. One important factor influencing the choice of position was the closing in towards the shore of sea-bed contours at the selected site. Mr. Cullen, late Engineer for Harbours and Marine, when giving evidence before the Committee of Inquiry, in commenting on the scheme, said: "I am in agreement with the reasons dictating the selection of the site. Access from the sea would be favourable from a navigation point of view, and as a vessel entering need not approach within 1,800-ft. of the shoal water off Slade Islet, the latter does not prejudice the approach."

Breakwaters

The full length of the southern breakwater will be 4,350-ft., and of the northern breakwater 3,375-ft.; and the height is given as 12-ft. above high spring tides. The stone (170-lb. to the cubic foot) used in exposed positions is of a minimum weight of seven tons, the smaller stone being used in the core of the breakwaters, and below low water beyond the influence of the sea. The outer slope is 1¼ to 1 and the inner slope 1 to 1. The top of the breakwaters has a minimum width of 27-ft., and the width of the base at the outer cants will be approximately 160-ft. Every precaution has been taken to ensure strength and stability of the breakwaters against cyclonic visitation.

Wharf and Sheds

The proposed wharfage is being provided by a concrete pier 766-ft. in length by 138-ft. in width, commencing from the end of a bank 750-ft. in length by 138-ft. in width, constructed of over-burden and small stone of the quarry, most of which could not be used in the breakwaters. This pier will be 646-ft. clear from the breakwater line at L.W. spring tides.

Provision has been made for two sheds, one on the pier approach bank for the storage of sugar only, and the other on the pier proper for storage of sugar and general cargo. A modern elevator system is to be installed.

Route

Communication with the city will be by rail and road, running almost parallel. The route is around the north-western side of Mount Bassett, crossing Vine Creek not far from the old traffic bridge and then running along the existing roadway by the rifle range. The road joins the main bitumen Mackay-Habana road at the northern approach of Barnes Creek Bridge. The total length of new road is 2 miles 45¼ chains and the width 26-ft., 20-ft. of which is bituminous penetration pavement 3-in. thick on a foundation of 5-in. consolidated "A" class course; the whole superimposed on a 4-in. consolidated course of sandy loam. The road is second only to concrete for stability and utility. The sandy loam has the important qualities of not only ensuring efficient under-drainage to the road, but also acts as an inflating course to prevent damp from penetrating upwards through the metal.

A road traffic bridge and railway bridge have been built across Vine Creek. Both are wooden structures on timber piers protected against cobra, toredo, etc. The road bridge has a bituminous deck wearing surface.

Railway bridges are being built across Barnes Creek (seven spans on concreted piers to rock), and Pioneer River in a line with Brisbane Street (44 spans on concrete piles). The bridge across the Pioneer River is curved so as to enable the railway line to pass down River Street and connect with the existing line in that thoroughfare.

The superstructure of both bridges will consist of steel girders and bracing supporting the permanent way.

A contract has been let to M. R. Hornibrook Pty, Ltd., for the construction of the concrete pier and the railway bridge across the Pioneer River at the prices of £238,891 10s. 10d. and £25,514 3s. 6d. respectively. The Board is constructing the remainder of the scheme. The ultimate cost of the whole scheme is expected to be in the vicinity of One Million Pounds (£1,000,000) and the Board will not have any difficulty in financing the repayment of expenditure of this order.

Outer Harbour Works

The Board decided on the 25th September to call tenders for the works in three sections, viz., Breakwaters and Pier Approach Bank; No. 1 Pier; and Brisbane Street Railway Bridge.

The tenders of M. R. Hornibrook Pty, Ltd., for the pier (£238,891 10s. 10d.) and for the railway bridge (25,514 3s. 6d.) were accepted.

The work on the breakwater was held up during the period August to November for the overhaul of plant, re-laying of rail track from the breakwater site to the quarry, and general rehabilitation.

The southern breakwater at the 31st March was out 1,900-ft. and the Pier Approach Bank 270-ft. The distances of the completed work are 4,300-ft. and 750-ft. respectively.

On the 25th September, 1936, the Board, on the recommendation of the Supervising Engineer, decided to change the berthage accommodation of the scheme from the Breast Wharf on the southern breakwater to the No. 1 Pier. The altered scheme of wharfage will enable the port to be used earlier than with the original proposal, and 1,532-ft. length of berthage will be provided instead of 1,200-ft. The width of the proposed pier is 138-ft., compared with 100-ft. width of the proposed Breast Wharf.

The top width of the breakwaters has been increased from 18-ft. to a minimum of 27-ft., in order to accommodate the Telpher crane with safety, besides giving added strength to the breakwaters.

Barnes Creek railway bridge is nearing completion. The northern and southern abutments and three piers are completed, leaving to be constructed, two piers, the superstructure to be placed in position, and the completion of embankment to the back of the abutments.

The expenditure on the whole of the works to the 31st March amounted to £383,087 14s. 2d.